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An investigation was performed on eight sites at Selfridge Air National Guard Base; Site 1 - Southwest Landfill, Site 2 - Fire Training Area 2, Site 3 - Fire Training Area 1, Site 4 - West Ramp, Site 5 - Tucker Creek Landfill, Site 6 - Northwest Landfill, Site 7 - East Ramp, and Site 8 - Base Coal Storage Pile. Further investigations were recommended for Sites 1 and 6 to better define the groundwater flow direction. No additional investigations were recommended at the other six sites.

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INSTALLATION RESTORATION PROGRAM (IRP)

PHASE II STAGE 2 INVESTIGATION

VOLUME I

127th FIGHTER WING
MICHIGAN AIR NATIONAL GUARD
SELFRIDGE AIR NATIONAL GUARD BASE
MT. CLEMENS, MICHIGAN

DECEMBER 1996

Prepared For

ANGRC/CEVR
ANDREWS AFB, MARYLAND

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DECEMBER 1996

Operational Technologies Corporation Prepared

- **Executive Summary**
- **Summary and Conclusions**

Roy F. Weston, Inc. Prepared

- **Introduction**
- **Results and Significance of Findings**
- **Field Investigation Program**
- **Environmental Setting**
- **Preliminary Feasibility Study**
- **Appendices A through Q**

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EXECUTIVE SUMMARY

Roy F. Weston, Inc. (WESTON) was retained by the United States Air Force Occupational and Environmental Health Laboratory (USAFOEHL) under contract No. F33615-80-D-4006, Task Order 0049, dated 17 September 1984 to conduct an Installation Restoration Program (IRP) Phase II Stage 1 Problem Confirmation/Quantification (Stage 1) investigation at Selfridge Air National Guard Base (ANGB). USAFOEHL authorized WESTON to conduct an IRP Phase II Stage 2 Confirmation/Quantification (Stage 2) investigation under Contract No. F33615-87-D-4018, Delivery Order 0002, on 25 September 1987. Authorization to proceed with the field work for the Stage 2 investigation was given by USAFOEHL on 11 December 1987. The field investigation was initiated on 14 December 1987 and completed 9 September 1988. All laboratory work was reported by 16 September 1988. A draft final report was submitted to USAFOEHL in January 1989.

Operational Technologies Corporation (OpTech) was retained by the National Guard Bureau (NGB) under contract DAHA90-91-D-0002/13 to evaluate the data collected by WESTON with respect to current applicable or relevant and appropriate requirements (ARARs) and to finalize the Stage 2 report.

OpTech evaluated the significance of environmental contaminant concentrations detected based on comparison to background conditions and Type B cleanup criteria listed in Michigan Environmental Response Act (MERA) Operational Memorandum #8, Revision 1, issued by Michigan Department of Natural Resources (MDNR) on 16 March 1992. Type B cleanup criteria are the maximum allowable levels below which no further remedial action may be recommended by the MDNR. The criteria were developed using currently available toxicological data and are subject to change as new data become available. Final cleanup criteria will be confirmed by the Environmental Response Division toxicologists and approved as part of a site-specific remedial action plan. Petroleum hydrocarbons were detected during the investigation however, the MDNR does not recognize petroleum hydrocarbons analysis for site characterization and no cleanup criteria levels have been established. The Stage 2 investigation did not include sampling of water, surface water, or soil for establishing background concentrations. Background levels for metals were determined through a statistical study conducted by WESTON.

ES.1 SCOPE OF WORK

The Stage 2 Statement of Work (SOW) issued by USAFOEHL authorized WESTON to investigate eight sites at Selfridge ANGB by completing the following tasks:

- Drill 29 soil borings.

- Collect 93 soil samples.

- Install 42 groundwater monitoring wells.

- Establish 24 surface water sampling locations.

- Install 6 continuous water level recorders, 3 at monitoring wells and 3 at adjacent stormwater drains, for 12 consecutive weeks of water levels recording.

- Develop 19 existing and 42 newly installed IRP monitoring wells.

- Test 19 existing and 42 newly installed IRP monitoring wells for hydraulic conductivity using slug test methods.

- Collect several rounds of water level measurements on all existing and newly installed IRP monitoring wells.

- Collect one round of groundwater samples from 19 existing and 42 newly installed IRP monitoring wells.

- Collect two rounds of surface water samples from 24 sampling locations, one round after an extended dry period and one round after a non-freezing precipitation event.

- Abandon two existing Stage 1 monitoring wells (04-114 (W-14) and 02-120 (W-20) damaged by base operations.

- Survey the elevation and location of all boreholes, monitoring wells, surface water stations, and continuous water level recorders.

ES.2 IRP SITE LOCATIONS

Selfridge ANGB is situated on the western shore of Lake St. Clair, 0.5 miles east of Mt. Clemens, Michigan. Selfridge ANGB occupies an area of approximately 3,184 acres and is bounded by Lake St. Clair on the east, the Clinton River on the south, and by open space and commercial and residential use to the north and west. The base facility is currently under the control of the Michigan Air National Guard, which serves as the host organization and maintains authority over base operations.

Seven of the eight sites investigated at Selfridge ANGB during the Stage 2 investigation had been investigated during the previous Stage 1 study. Site 8 (ANG Site 10), the Base Coal Storage Pile (BCSP) was added to the Stage 2 investigation at the request of base personnel.

Note: ANG Site 10 was renumbered in this report as Site 8 after ANG Site 8, "Perimeter Road-Waste Oil Dust Control" and ANG Site 9, "Wastewater Treatment Plant Sludge Application", (identified in the Phase I Records Search (1983) as a low potential area of concern) were deleted from further consideration due to their widespread distribution, consequent dilution, and a determination that they posed no treat to human health and the environment.

The eight sites are briefly described as follows:

- Site No. 1, Southwest Landfill (SWLF), was used in the past to dispose of residential and industrial waste. Currently, the site is used for disposing demolition and landscape debris, and ash from the base coal-fired power plant. The site is 40 acres in size and is located in the southwestern corner of the base.

- Site No. 2, Fire Training Area 2 (FTA-2), has been used to conduct fire training exercises since 1964. The site is 40 acres in size and is also located in the southwestern part of the base, north of the SWLF.

- Site No. 3, Fire Training Area 1 (FTA-1), was used for fire training exercises until 1959. The pit is unlined and has been backfilled with gravel. Currently, the area is surrounded by a security fence and is used as an unpaved parking area. FTA-1 is 0.25 acres in size and is located north of FTA-2, near Building 567.

- Site No. 4, West Ramp (WRMP), is a flightline apron area, bounded on the north by the Northwest Landfill, on the east by the airfield, on the south by an undeveloped wooded area, and on the west by aircraft hangers and support buildings. The ramp is utilized for aircraft parking, maintenance, and fueling. The site covers 85 acres and is located in the northwestern portion of the base.

- Site No. 5, Tucker Creek Landfill (TCLF), is a natural depression on the eastern side of Selfridge ANGB which was used for disposing waste materials. The TCLF is bounded on the north by Building 970, on the south by the

base school, on the east by Lake St. Clair, and on the west by Jefferson Avenue. The site is approximately 9 acres in size.

- Site No. 6, Northwest Landfill (NWLF), was originally a natural sand pit that was excavated for use in runway construction. It was afterwards used for waste disposal. The site is bounded by Perimeter Road to the north, the airfield to the east, West Ramp to the south, and the radar station to the west. The NWLF is 26 acres in size and is located in the northwestern part of the base.

- Site No. 7, East Ramp (ERMP), is utilized for aircraft parking, maintenance, and fueling. ERMP is bounded on the north and east by Wilbur Wright Avenue, to the south by the golf course, and to the west by the airfield. The ramp covers 75 acres and is located in the southeastern portion of the base.

- Site No. 8 (ANG Site 10), Base Coal Storage Pile (BCSP) was used to store coal for the coal-fired power plant. The BCSP is 5 acres in size and is located on the eastern side of the base.

ES.3 SUMMARY OF STAGE 1 INVESTIGATION

WESTON conducted field work for the Stage 1 investigation from November 1984 to June 1985. The scope of the investigation included:

- Installing 25 groundwater monitoring wells.

- Establishing five surface water sampling locations.

- Collecting and analyzing 27 soil samples from 9 locations.

- Collecting and analyzing one round of water quality samples from all groundwater monitoring wells and surface water stations.

- Collecting three rounds of water level measurements from each of the newly installed monitoring wells.

Groundwater and surface water samples were analyzed for total organic carbon (TOC), total phenols, chemical oxygen demand (COD), cadmium, chromium, copper, lead, nickel, zinc, total petroleum hydrocarbons (TPH), oil and grease (O&G), volatile organic compounds (VOCs), pH, temperature, and specific conductance. Soil samples were analyzed for VOCs, O&G, ignitability, and EP toxicity for arsenic, barium, cadmium, chromium, mercury, lead, selenium, and silver. All samples were analyzed by the WESTON Analytics Laboratory in Lionville, Pennsylvania.

During the Stage 1 investigation, fifteen soil samples were collected at Site No. 4, WRMP, from monitoring well borings 04-111, 04-112, 04-113, 04-114, and 04-115. All samples were submitted for laboratory analysis of VOCs and O&G. All soil samples collected, with one exception, contained trichloroethene, and all samples contained one or two solvents. Reportedly, the only distinctive pattern of contamination readily observable was in soil samples collected from monitoring well boring 04-115, which was located adjacent to the source of the January 1984 spill. O&G was detected at a concentration of 17,900 mg/kg and toluene was detected at concentrations ranging from 25,000 to 104,000 mg/kg, as well as other solvents, in the samples collected from a depth of 2.5 to 7.5 feet BLS from monitoring well boring 04-115.

During the Stage 1 investigation, twelve soil samples were collected at Site No. 7, ERMP, from monitoring well borings 07-101, 07-102, 07-103, and 07-104. All samples were submitted for laboratory analysis of VOCs and O&G. O&G were detected at concentrations ranging from 69 to 229 mg/kg. Six VOCs were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels for soil. The analyses reportedly detected chloroform at concentrations ranging from 2 to 490 mg/kg, methylene chloride from 3 to 1,800 mg/kg, toluene from 2 to 60 mg/kg, 1,1,1-trichloroethane from 2 to 2,100 mg/kg, 1,1,2-trichloroethane from 2 to 1,000 mg/kg, and trichloroethene from 107 to 6,800 mg/kg. All samples contained trichloroethene, with the highest concentrations detected predominantly in the 15.5 and 25 feet BLS interval.

ES.4 FINDINGS OF STAGE 2 INVESTIGATION

Contaminants in soil, groundwater, and surface water were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels and/or estimated background levels for each respective media. Maximum concentrations of analytes detected in soil samples

collected at Sites No. 1 through 8 during the Stage 2 investigation which exceeded Act 307 Type B Cleanup Criteria levels for soil and/or estimated background levels are listed in Table ES.1.

Maximum concentrations of analytes detected in groundwater samples collected at Sites No. 1 through 8 during the Stage 2 investigation which exceeded Act 307 Type B Cleanup Criteria levels for groundwater and/or estimated background levels are listed in Table ES.2.

Maximum concentrations of analytes detected in surface water samples collected at Sites No. 1 through 8 during the Stage 2 investigation which exceeded Act 307 Type B Cleanup Criteria levels for groundwater/surface water interface (GSI) and/or estimated background levels are listed in Table ES.3.

ES.5 CONCLUSIONS AND RECOMMENDATIONS

ES.5.1 Site No. 1 (SWLF)

Petroleum hydrocarbons and mercury, nickel, and zinc were detected in soil samples below a depth of 10 feet BLS. Nine VOCs, petroleum hydrocarbons, and metals contamination were detected in groundwater samples collected from shallow monitoring wells. The VOC methylene chloride, petroleum hydrocarbons, and cadmium were detected in groundwater samples collected from deep monitoring wells. Barium, cadmium, chromium, and copper were detected at concentrations exceeding Act 307 Type B cleanup criteria and/or estimated background levels in surface water samples collected from a ponding area located on the east side of the SWLF.

Saturated conditions were encountered at depths ranging from 5 to 15 feet BLS. The static water levels in these shallow monitoring wells ranged between 1.4 to 2.66 and 2.75 to 8.93 feet BLS during the water level measurements taken on 21 March and 1 August 1988, respectively. The static water levels in the deep monitoring wells ranged from 5.07 to 7.32 and 5.42 to 7.00 feet BLS during water level measurements taken on the same dates. Hydraulic conductivity (K) values determined for monitoring wells at SWLF ranged from 2.90 x 10^{-5} to 5.66 x 10^{-8} ft/sec.

Table ES-1
Maximum Concentrations Detected in Soil Samples Exceeding Act 307 Type B Cleanup Criteria and/or Estimated Background Levels
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Total Number of Investigative Samples	SITE NO. 1 SWLF 4	SITE NO. 2 FTA-2 9	SITE NO. 3 FTA-1 9	SITE NO. 4 WRMP 31	SITE NO. 5 TCLF 24	SITE NO. 6 NWLF 2	SITE NO. 7 ERMP 7	SITE NO. 8 BCSP 9	Act 307 Type B Cleanup Criteria and/or Estimated Background[a] Levels (mg/kg)
PARAMETER (Reported in mg/kg)									
Arsenic		41.1	24.4		43.2				20.0[a]
Benzene		0.96							0.02
Benzo(a)anthracene			0.78						0.2
Benzo(b)fluoranthene			0.65						0.2
Benzo(k)fluoranthene			0.37						0.2
Benzo(g,h,i)perylene	0.11		0.68		0.1				ID
Benzo(a)pyrene			0.73						0.2
Bis(2-ethylhexyl)phthalate	0.12		0.65		0.4				0.04
Boron						52.9			36[a]
Cadmium			32.5						2.0[a]
Chrysene			0.76						0.2
Cobalt			21.7						14.2[a]
Copper		3.7			44.1				25[a]
Ethylbenzene									1.4
Indeno(1,2,3-c,d)pyrene			0.7						0.2
Lead	22.9				82.2				--
Mercury	0.959	0.54							0.040
Methylene chloride									0.1
Nickel	382	3,800	337						41.8[a]
Petroleum hydrocarbons	180		1,400	130	120	96	99		ND
Phenanthrene	0.18		1.2		0.15				ID
Vinyl chloride		15	0.19						0.0004
Xylenes									6
Zinc	78.3				95.6				70[a]

mg/kg = milligrams per kilogram.
ID = Insufficient data.
ND = Not determined.
[a] = Background level criteria.

Table ES-2
Maximum Concentrations Detected in Groundwater Samples Exceeding Act 307 Type B Cleanup Criteria and/or Estimated Background Levels
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Total Number of Investigative Samples	SITE NO. 1 SWLF 12	SITE NO. 2 FTA-2 3	SITE NO. 3 FTA-1 3	SITE NO. 4 WRMP 12	SITE NO. 5 TCLF 9	SITE NO. 6 NWLF 7	SITE NO. 7 ERMP 11	SITE NO. 8 BCSP 4	Act 307 Type B Cleanup Criteria and/or Estimated Background[a] Levels
PARAMETER									
1,2-dichloroethane	3.1 ug/L								0.4 ug/L
1,1,2,2-tetrachloroethane	7.3 ug/L								0.2 ug/L
1,4-dichlorobenzene	9.0 ug/L				2 ug/L				1.0 ug/L
Arsenic	0.01 mg/L				0.007 mg/L	0.01 mg/L			0.00002 mg/L
Benzene	60 ug/L			2 ug/L	2 ug/L				1.0 ug/L
Bis(2-ethylhexyl)phthalate	26 ug/L				4 ug/L	9 ug/L		15 ug/L	2.0 ug/L
Boron	1.35 mg/L								0.6 mg/L
Cadmium	132.0 mg/L				0.008 mg/L			0.013 mg/L	0.004 mg/L
Chloride	1,820 mg/L			415 mg/L	2,360 mg/L		553 mg/L	6,800 mg/L	250 mg/L
Iron	700 mg/L								0.3 mg/L
Lead					0.005 mg/L				I
Methylene chloride	310 ug/L								5 ug/L
Petroleum hydrocarbons	6 mg/L	1 mg/L	1 mg/L	2 mg/L	4.1 mg/L		2.1 mg/L		ND
Phenanthrene								3 ug/L	ID
Sulfate	475 mg/L	292 mg/L		962 mg/L	260 mg/L	432 mg/L			250 mg/L
Tetrachloroethene	3.9 ug/L								0.07 ug/L
Total Dissolved Solids	5,900 mg/L				4,500 mg/L		13,000 mg/L	12,000 mg/L	1,400 mg/L[a]
Trans-1,2-dichloroethene	650 ug/L								100 ug/L
Trichloroethene	170 ug/L				4.1 ug/L				3.0 ug/L
Vinyl chloride	68 ug/L								0.02 ug/L
Zinc	1.74 mg/L								1.0 mg/L

ug/L = micrograms per Liter.
mg/L = milligrams per Liter.
I = Under review.
ID = Insufficient data.
ND = Not determined.

Table ES-3
Maximum Concentrations Detected in Surface Water Samples Exceeding Act 307 Type B Cleanup Criteria and/or Estimated Background Levels
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Total Number of Investigative Samples	SITE NO. 1 SWLF	SITE NO. 2 FTA-2	SITE NO. 3 FTA-1	SITE NO. 4 WRMP	SITE NO. 5 TCLF	SITE NO. 6 NWLF	SITE NO. 7 ERMP	SITE NO. 8 BCSP	Act 307 Type B Cleanup Criteria and/or Estimated Background[a] Levels
	10	7	0	8	10	4	8	0	
PARAMETER									
4-nitrophenol	12 ug/L								N/A
Arsenic						0.242 mg/L			0.180 mg/L
Barium	0.518 mg/L					1.31 mg/L			0.354 mg/L[a]
Boron	0.942 mg/L								N/A
Butyl benzyl phthalate	6 ug/L				3 ug/L	4 ug/L			N/A
Cadmium	0.066 mg/L				0.008 mg/L	0.02 mg/L			0.0006 mg/L
Chloride					1,340 mg/L				186 mg/L[a]
Chromium	0.022 mg/L	0.024 mg/L			0.017 mg/L	0.188 mg/L			0.0017 mg/L
Copper	0.032 mg/L	0.034 mg/L			0.035 mg/L	0.238 mg/L			0.018 mg/L
Diethyl phthalate	6 ug/L								N/A
Di-n-butyl phthalate	2 ug/L				2 ug/L	1 ug/L			N/A
Lead		0.17 mg/L			0.033 mg/L	0.592 mg/L			0.008 mg/L
Methylene chloride		390 ug/L							59 ug/L
Nickel						0.269 mg/L			0.057 mg/L
Petroleum hydrocarbons	2.4 mg/L	2 mg/L		2 mg/L	2.5 mg/L	1.7 mg/L	4.6 mg/L		ND
Sulfate	325 mg/L								100 mg/L[a]
Toluene							178 ug/L		111 ug/L
Total Dissolved Solids					2,500 mg/L				690 mg/L[a]
Trichlorofluoromethane	150 ug/L								N/A

ug/L = micrograms per Liter.
mg/L = milligrams per Liter.
N/A = Not available.
ND = Not determined.

Shallow groundwater velocities were relatively high for the base. Calculated rates were 244 and 609 ft/yr for the shallow monitoring wells on 21 March and 1 August 1988, respectively. Rates were 3.15 ft/yr on 21 March and 6.28 ft/yr on 1 August 1988 for the deep monitoring wells.

Data collected during the Stage 2 investigation did not adequately define groundwater flow direction to the west and northwest of the SWLF. Therefore, it is recommended that six piezometer wells, three shallow wells and three deep wells, be installed west and northwest of the SWLF to establish the groundwater gradient direction at the site. Additional soil, groundwater and surface water investigations are not recommended at the SWLF. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five stormwater pump stations is recommended to determine if contaminants are migrating.

ES.5.2 Site No. 2 (FTA-2)

Petroleum hydrocarbons and the VOCs methylene chloride, benzene, ethylbenzene, and xylenes were detected in soil samples collected from the upper 10 feet BLS of soil, but primarily in the first 5 feet BLS. Petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 1 mg/L. Chromium, copper, and lead were detected at concentrations exceeding Act 307 Type B cleanup criteria in surface water samples collected at sampling station 02-507, located within a shallow depression northeast of the site.

Saturated conditions were encountered at depths ranging from 10 to 11 feet BLS. The static water levels in these wells ranged from 1.53 to 3.66 and 11.57 to 13.27 feet BLS during water level measurements taken on 21 March and 1 August 1988 respectively. Direction of groundwater flow is not consistent at the site. Groundwater flow was in a northerly direction based on water level measurements taken on 21 March and 17 May 1988. For the periods 20 June and 1 August 1988 groundwater flow was determined to be in a southeast direction. A groundwater gradient of 0.008 ft/ft was calculated on 21 March 1988. A gradient of 0.006 ft/ft was calculated for the period of 20 June and 1 August 1988. Measured K values at FTA-2 ranged from 1.95×10^{-6} ft/sec to 7.47×10^{-7} ft/sec. Groundwater flow at FTA-2 was calculated to be 1.80 ft/yr in a northerly direction and 1.35 ft/yr in a southeasterly direction.

Additional soil, groundwater and surface water investigation is not recommended at FTA-2. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five

stormwater pump stations is recommended to determine if contaminants are migrating.

ES.5.3 Site No. 3 (FTA-1)

Petroleum hydrocarbons and arsenic, cadmium, and nickel were detected in soil samples collected to a depth of 25.0 feet BLS. Petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 1 mg/L.

Saturated conditions were encountered at depths ranging from 11.5 and 13 feet BLS. The static water levels in these wells ranged from 3.17 to 3.35 and 7.0 to 8.84 feet deep, measured from top of inner casing of each well, during water level measurements taken on 21 March and 1 August 1988 respectively. Direction of groundwater flow is not consistent at the site. Groundwater flow was to the northeast based on water level measurements taken on 21 March 1988. On 1 August 1988 groundwater flow was to the north. The groundwater gradient on 21 March 1988 was approximately 0.002 ft/ft. On 1 August 1988 the groundwater gradient was 0.005 ft/ft. The average K value was 4.32 x 10^{-5} ft/sec. Groundwater flow velocity at FTA-1 was calculated to be 45.4 ft/yr to the north and 18.2 ft/yr to the northeast.

Additional soil, groundwater and surface water investigation is not recommended at FTA-1. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five stormwater pump stations is recommended to determine if contaminants are migrating.

ES.5.4 Site No. 4 (WRMP)

VOCs and petroleum hydrocarbons were detected in soil samples collected in the area adjacent to the source of the January 1984 spill. Benzene and petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 2 ug/L and 2 mg/L, respectively. Petroleum hydrocarbons were detected at a maximum concentration of 2 mg/L in dry-event surface water samples.

Saturated conditions were encountered at depths ranging from 5 to 12 feet BLS. The static water levels in the shallow monitoring wells ranged from 0.75 to 5.1 and 2.5 to 5.82 feet BLS during water levels measurements taken on 21 March and 1 August 1988 respectively. The static water levels in the deep monitoring wells ranged from 1.9 to 3.55 and 2.18 to 3.22 feet BLS during water level measurements taken on the same dates. Groundwater flow is generally toward the east. Horizontal gradients of 0.003 ft/ft and 0.0004 ft/ft were calculated for the shallow monitoring wells on 21

March and 1 August 1988, respectively. A horizontal gradient of 0.0014 ft/ft was calculated for the deep wells on 21 March and 1 August. The average K value was 9.2×10^{-7} ft/sec. Calculated groundwater velocities were from 0.10 to 0.72 ft/yr for the shallow monitoring wells and 0.14 ft/yr for the deep wells.

Additional soil, groundwater and surface water investigation is not recommended at WRMP. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five stormwater pump stations is recommended to determine if contaminants are migrating.

ES.5.5 Site No. 5 (TCLF)

Arsenic and zinc were detected at concentrations marginally greater than background levels in soil borings drilled within the defined boundary of the TCLF. It should be noted that methane was reported in several soil borings at the TCLF. Elevated indicator parameters and metals concentrations, characteristic of landfill leachate, were detected in groundwater. Petroleum hydrocarbons were detected in both the shallow and deeper aquifer underlying the TCLF; however, the TCLF does not appear to be the source of contamination. The greatest concentration of petroleum hydrocarbons detected in the shallow aquifer is south and upgradient to the site. The greatest concentration of petroleum hydrocarbons detected in the deeper aquifer appears to the west of the site. Metals were detected in surface water samples at concentrations exceeding Act 307 Type B cleanup criteria levels. Cadmium, chromium, copper, and lead were detected in surface water collected from sampling station 05-515. Copper and lead were detected at sampling station 05-516 located in a stormwater sewer line downgradient to sampling station 05-515.

Saturated conditions were encountered at depths between 7 to 13 feet BLS. The static water levels in the shallow monitoring wells ranged from 1.85 to 7.22 and 4.53 to 6.78 feet BLS during water levels measurements taken on 21 March and 1 August 1988 respectively. The static water levels in the deep monitoring wells ranged from 2.11 to 3.89 and 2.61 to 6.78 feet BLS during water level measurements taken on the same dates. Based upon the potentiometric surface maps, groundwater flow is generally toward the east across the site, but along the shoreline, flow is westward. Site gradients for shallow monitoring wells ranged from 0.005 ft/ft on 21 March 1988 to 0.008 ft/ft on 1 August 1988. The gradient for deep monitoring wells was approximately 0.003 ft/ft. The average K for the shallow and deep monitoring wells was 1.08×10^{-6} ft/sec and 3.51×10^{-7} ft/sec, respectively. Groundwater flow velocity on 21 March was 1.14 ft/yr and on 1 August 1988 was 1.82 ft/yr for shallow monitoring wells. Calculated groundwater flow

velocity was 0.22 ft/yr on 21 March and 0.29 ft/yr on 1 August 1988 for deep monitoring wells.

Additional water investigation is not recommended at TCLF. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five stormwater pump stations is recommended to determine if contaminants are migrating.

ES.5.6 Site No. 6 (NWLF)

Metals were detected at concentrations exceeding Act 307 Type B cleanup criteria levels in groundwater and surface water samples collected at Site No. 6. Arsenic was detected in groundwater samples at a maximum concentration of 0.01 mg/L. Arsenic, cadmium, chromium, copper, lead, and nickel were detected in surface water samples collected from a catch basin located along a sewer line that drains the eastern portion of the NWLF.

Saturated conditions were encountered at depths between 10 to 12 feet BLS. The static water levels in the shallow monitoring wells ranged from 0.72 to 1.76 and 3.6 to 6.04 feet BLS during water level measurements taken on 21 March and 1 August 1988 respectively. The static water levels in the deep monitoring wells ranged from 3.49 to 4.51 and 3.04 to 5.28 feet BLS during water level measurements taken on the same dates. A groundwater high exists in the northeastern corner of the site. Based upon information collected from shallow monitoring wells on 21 March 1988, groundwater flow was determined to be toward the northwest and southwest, away from the groundwater high. Along the southern end of the site groundwater flow direction was toward the south. Information collected on 1 August 1988 shows groundwater flow occurred radially away from the groundwater high. Groundwater on the western side of the site moved in a southeasterly direction. Based upon information collected from deep monitoring wells on 21 March 1988, groundwater flow was determined to be toward the south and southeast. Information collected on 1 August 1988 shows that groundwater flow was to the south and southeast from the site toward WRMP. Site gradients for shallow monitoring wells ranged from 0.005 ft/ft on 21 March 1988 to 0.01 ft/ft on 1 August 1988. The gradient for deep monitoring wells ranged from 0.003 ft/ft on 21 March 1988 to 0.002 ft/ft on 1 August 1988. The average hydraulic conductivity value with respect to both shallow and deep monitoring wells was 3.34×10^{-6} ft/sec. Shallow groundwater velocity was calculated as 3.60 ft/yr and 7.16 ft/yr on 21 March and 1 August 1988, respectively. Deep groundwater velocity was calculated as 2.00 ft/yr and 1.33 ft/yr on the same dates.

Data collected during the Stage 2 investigation did not adequately define groundwater flow direction to the east of the NWLF.

Therefore, it is recommended that six piezometer wells, three shallow wells and three deep wells, be installed east of the NWLF to establish the groundwater gradient direction at the site. Additional soil, groundwater and surface water investigation is not recommended at the NWLF. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five stormwater pump stations is recommended to determine if contaminants are migrating.

ES.5.7 Site No. 7 (ERMP)

Petroleum hydrocarbons were detected at concentrations less than 100 mg/kg in soil samples collected below a depth of 20 feet BLS. Petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 2.1 mg/L. Toluene was detected in one surface water sample at a concentration exceeding Act 307 Type B cleanup criteria.

Saturated conditions were encountered at depths between 9 to 12 feet BLS. The static water levels in the shallow monitoring wells ranged from 2.04 to 5.24 and 5.3 to 6.55 feet BLS during water level measurements taken on 21 March and 1 August 1988 respectively. The static water levels in the deep monitoring wells ranged from 2.55 to 7.38 and 2.53 to 5.04 feet BLS during measurements taken on the same dates. Based on information collected from shallow monitoring wells on 21 March 1988, the groundwater flow along the southern portion of the site was determined to be toward the northeast, while near Lake St Clair, groundwater flow reverses to the southwest toward the site. Information collected on 1 August 1988 indicates groundwater flow remains approximately the same as on 21 March 1988. Based on data collected from deep monitoring wells on 21 March and 1 August 1988, the groundwater flow was determined to be from the north and south toward a trough in the potentiometric surface underlying ERMP. Horizontal gradients of 0.004 ft/ft and 0.003 ft/ft were determined at shallow monitoring wells on 21 March and 1 August 1988, respectively. A gradient of 0.002 ft/ft was determined for 21 March and 1 August 1988 at deep monitoring wells. ERMP shallow monitoring wells have an average K value of 6.63×10^{-6} ft/sec. Deep monitoring wells have an average K value of 1.05×10^{-6} ft/sec. Shallow groundwater flow velocities range from 4.20 to 5.59 ft/yr. Deep groundwater flow velocities are 0.44 ft/yr.

Additional soil, groundwater and surface water investigation is not recommended at the ERMP. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five stormwater pump stations is recommended to determine if contaminants are migrating.

ES.5.8 Site No. 8 (ANG Site 10) (BCSP)

Elevated chloride and TDS concentrations detected in groundwater samples appear to be related to the road-salt pile located adjacent to the BCSP.

Saturated conditions were encountered at depths between 7 to 16 feet BLS. The static water levels in these wells ranged from 1.33 to 4.69 and 2.32 to 6.83 feet BLS during water level measurements taken on 21 March and 1 August 1988 respectively. Based upon water level data for all measurement periods between 1 February and 1 August 1988, a groundwater divide exists at the site. Groundwater flow from the BCSP along the divide diverges in a northeasterly direction and in a southerly direction. A horizontal gradient of 0.02 ft/ft was calculated at shallow monitoring wells. The average K value was 1.28×10^{-6} ft/sec. The shallow groundwater flow velocity was calculated to be 5.39 ft/yr.

Additional soil, groundwater and surface water investigation is not recommended at the BCSP. This recommendation is based on interpretation that the stormwater collection system will prevent off-site migration of contaminants except from stormwater pump stations. Periodic monitoring of discharge from each of the five stormwater pump stations is recommended to determine if contaminants are migrating.

ES.6 GENERAL COMMENTS AND RECOMMENDATIONS

Base-wide groundwater potentiometric surface maps indicate that groundwater at the base is not discharging directly to Lake St. Clair or to the Clinton River, but to a closed potentiometric low adjacent to Lake St. Clair. The stormwater drainage system is interpreted to be the discharge mechanism responsible for the potentiometric low. The stormwater drainage system appears to intercept groundwater which is eventually discharged either to Lake St. Clair or the Clinton River by means of five pump or lift stations.

The stormwater system at Site No. 1, the SWLF, and Site No. 2, the FTA-2, is interpreted to intercept groundwater from the sites and eventually discharges to the Clinton River by the pump station located at Building 507. Likewise, surface water drainage from the area around Site No. 1 would flow to the drainage ditch and would be transported to the Clinton River by way of the same pump station. The stormwater drainage system at Site No. 4, the WRMP, and Site No. 6, the NWLF, is interpreted to be intercepting groundwater from the sites and eventually discharging to Lake St. Clair by the pump station located at Building 994. The stormwater drainage system at Site No. 5, the TCLF, is interpreted to be intercepting groundwater from the site and eventually discharging to Lake St. Clair by the pump station located at Building 980. The

stormwater drainage system at Site No. 7, the ERMP, is interpreted to be intercepting groundwater from the site and eventually discharging into Lake St. Clair by the pump station located in Building 340, and to the Clinton River by the pump station located in Building 508.

Periodic monitoring is recommended to be initiated at all five stormwater lift stations. The periodic monitoring should be included in the base environmental pollution monitoring program.

Sampling and laboratory analysis should be conducted as required in the National Pollution Discharge Elimination System (NPDES) permit.

Additional piezometer wells should be installed at the SWLF and NWLF. A minimum of one round of groundwater measurements of all monitoring and piezometer wells should be collected and a base-wide potentiometric map prepared.

SECTION 1

INTRODUCTION

1.1 PURPOSE OF THE INSTALLATION RESTORATION PROGRAM

In 1976 the Department of Defense (DOD) initiated the Installation Restoration Program (IRP) to evaluate, characterize, and control the potential migration of possible contaminants resulting from past operations and disposal practices on DOD facilities. In response to the Resource Conservation and Recovery Act (RCRA) of 1976 and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), DOD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM) dated June 1980 (DEQPPM 80-6) requiring identification of past hazardous waste disposal sites on DOD agency installations. The U.S. Air Force implemented DEQPPM 80-6 in December 1980. The program was revised by DEQPPM 81-5 (11 December 1981) which re-issued and amplified all previous directives and memoranda on the IRP. The Air Force implemented DEQPPM 81-5 on 21 January 1982.

The IRP was originally developed as a four-phase program as follows:

- Phase I -- Problem Identification/Records Search
- Phase II -- Problem Confirmation/Quantification Study
- Phase III -- Technology Base Development
- Phase IV -- Corrective Action

The purpose of the phased approach was to initiate a detailed review of historical practices, followed by an effective field investigation and, ultimately, remedial design and cleanup, if warranted. Since initiation of the IRP, significant experience in all phases of the program has been gained, and evolution of the approach has occurred. Based on experience at DOD facilities nationwide, the U.S. Air Force has adopted an approach that streamlines and integrates elements of the program by allowing remedial investigations to progress simultaneously with feasibility studies of potential remedial alternatives. This integrated approach brings parts of Phase IV within the general execution of Phase II.

1.2 IRP AT SELFRIDGE AIR NATIONAL GUARD BASE

This subsection describes the progress of the IRP at Selfridge Air National Guard Base (Selfridge ANGB), including previous IRP

investigations and the current scope of work. Appendix A contains a glossary of relevant terms and acronyms used throughout this report.

1.2.1 Previous IRP Investigations

The DOD retained Environmental Control Technology Corporation (ENCOTEC) to conduct a Phase I Problem Identification/Records Search at Selfridge ANGB under Contract No. DAHA 20-82-C-6065 in 1983. In its April 1983 Phase I Report, ENCOTEC identified seven sites possessing a moderate potential for contaminant migration based on the USAF Hazard Assessment Rating Methodology (HARM).

In April 1984, Roy F. Weston, Inc. (WESTON) was retained by the U.S. Air Force Occupational and Environmental Health Laboratory (USAFOEHL) under contract F33615-80-D-4006 and was assigned to perform a Pre-Survey Study under Task Order 0037. Based on the Pre-Survey Report submitted by WESTON in May 1984, USAFOEHL authorized WESTON to provide engineering, hydrogeological, and analytical services for a Phase II Stage 1 Problem Confirmation/Quantification investigation at Selfridge ANGB under Task Order 0049 dated 17 September 1984. The investigation was designed to confirm the presence or absence of contamination and to identify the potential for off-site migration at the seven sites identified in the Phase I Report. The findings of the Phase II Stage 1 investigation were detailed in the Final Report submitted in October 1986. Based on the hydrogeologic complexity of the physical setting and the findings of the sampling and analytical work, WESTON recommended followon investigations at all seven sites.

1.2.2 Scope of Work

On 25 September 1987, USAFOEHL authorized WESTON to conduct an IRP Stage 2 Confirmation/Quantification (IRP Stage 2) investigation under contract F33615-87-D-4018, Delivery Order 0002. A copy of the Statement of Work (SOW) for this Delivery Order, as modified, is provided in Appendix B. In terms of additional field investigations, the SOW authorized WESTON to:

- Drill 29 soil borings.
- Collect 93 soil samples.
- Install 42 groundwater monitor wells.
- Establish 24 surface water sampling locations.
- Install six continuous water level recorders, three at wells and three at adjacent storm drains for 12 consecutive weeks of water levels recording.
- Develop 19 existing and 42 newly installed IRP monitor wells.

- Test 19 existing and 42 newly installed IRP monitor wells for hydraulic conductivity using slug test methods.

- Collect several rounds of water level measurements on all existing and newly installed IRP monitor wells.

- Collect one round of groundwater samples from 19 existing and 42 newly installed IRP monitor wells.

- Collect two rounds of surface water samples from 24 sampling locations, one round after an extended dry period and one round after a non-freezing precipitation event.

- Survey the elevation and location of all boreholes, monitor wells, surface water stations, and continuous water level recorders.

The field program was designed to gather the information necessary to confirm and quantify the nature and extent of environmental hazards, if any, associated with each site, so that feasibility studies could be initiated (if necessary) to evaluate potential alternative remedial actions. In addition, a qualitative risk assessment was to be performed to identify which sites present a potential threat to human health and/or the environment and which sites (if any) might qualify for a finding of No Further Action (NFA). The IRP Stage 2 effort was designed to meet the following objectives:

- Provide information to evaluate more completely the types of contaminants at each site, the environmental media (pathways) affected, and the extent of contamination.

- Develop detailed descriptions of the environmental factors that must be understood to design appropriate remedial actions.

- Apply the remedial investigation and risk assessment data to the technologies screening and alternatives development portions of the feasibility study.

- Develop findings of No Further Action for those sites identified as not posing a threat to human health or the environment, and recommend further studies and identify data quality objectives (where applicable) at those sites requiring further action.

The investigation was conducted in several steps. The first step was preparation of planning documents for the field work: the Work Plan (WP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HSP). These planning documents were submitted to the USAFOEHL for approval on 20 November 1987.

Authorization to proceed with the field work was given by USAFOEHL on 11 December 1987. The field investigation was initiated on 14 December 1987 and continued until 9 September 1988. All laboratory results were reported by 16 September 1988. An Informal Technical Information Report (ITIR) was submitted in October 1988.

1.3 SITE HISTORY

The information in this subsection was summarized from the following documents:

- April 1983, "IRP Phase I Records Search Selfridge ANGB" by Environmental Control Technology Corporation for USAFOEHL.
- October 1986, "IRP Phase II Stage 1 Confirmation/ Quantification Selfridge ANGB" by Roy F. Weston for USAFOEHL.
- December 1986, "Sampling and Analysis of Soils and Groundwater at Selfridge ANGB" by Clayton Environmental Consultants for U.S. Army Corp of Engineers.
- January 1988, "Draft Remedial Action Plan for Clinton River Area of Concern" by Michigan Department of Natural Resources.

Further information was obtained from aerial photographs and documents stored at the Selfridge ANGB Museum and from conversations with Col. Robert Stone, USAF (Retired), Curator of the Museum. Additional sources included the Mt. Clemens Chamber of Commerce and the Macomb County Planning Commission.

1.3.1 Base History

Selfridge ANGB is situated on the western shore of Lake St. Clair, 0.5 miles east of Mt. Clemens, Michigan, as shown in Figure 1-1. Figure 1-2 is a map of Selfridge ANGB showing the locations of the IRP sites addressed during this investigation.

In 1917 the U.S. Army leased 640 acres of farm land and began construction of Selfridge Field. Five years later the initial base area was purchased, establishing the facility as a permanent installation. Considerable expansion occurred during World War II, with the base reaching its present size of 3,184 acres. Selfridge Field remained under the administration of the U.S. Army until 1947 when the Air Force was established as a separate service and the base became a U.S. Air Force installation. In 1971 control of the facility was transferred to the Michigan Air National Guard which currently serves as the host organization and maintains authority over base operations.

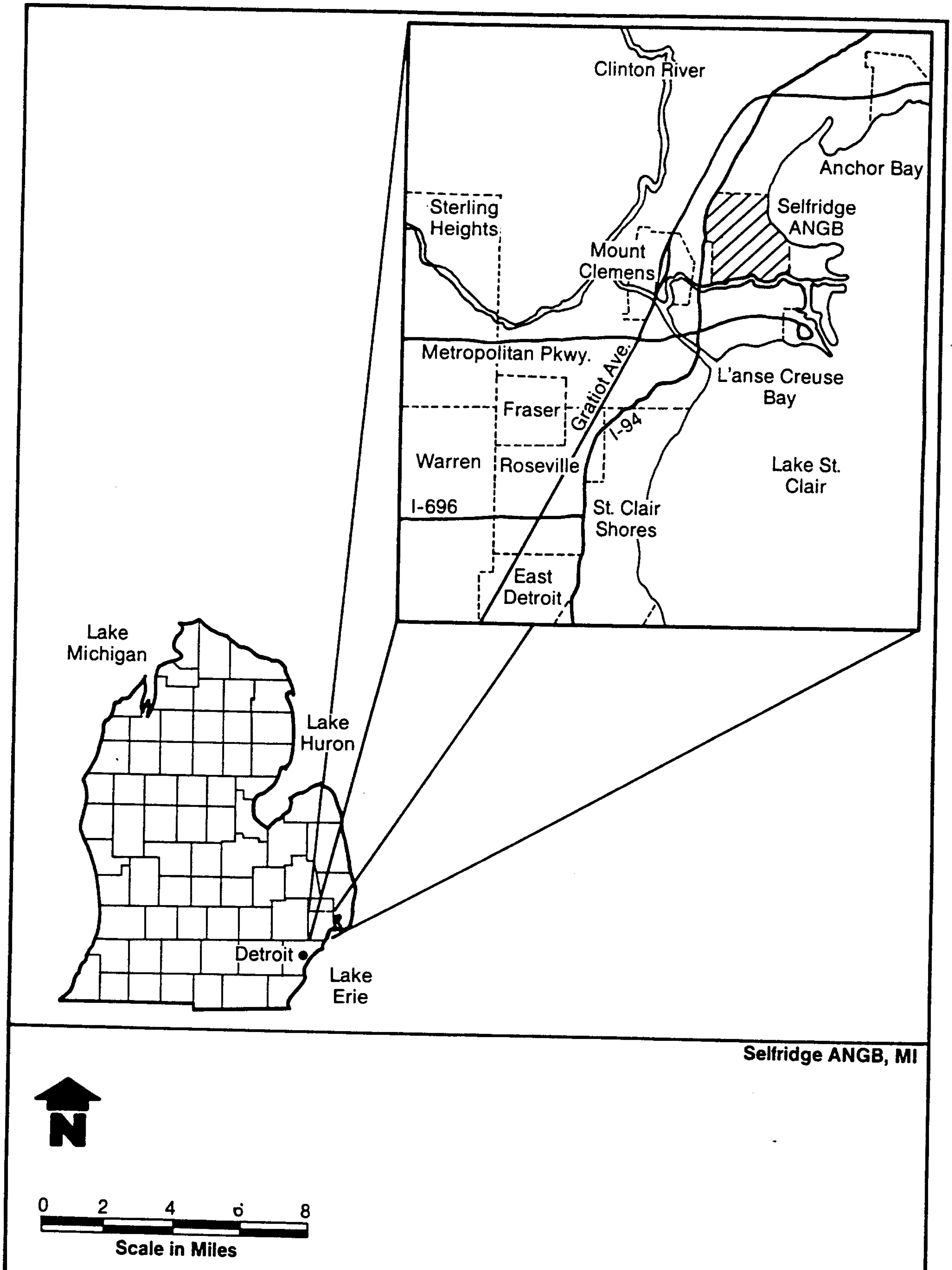
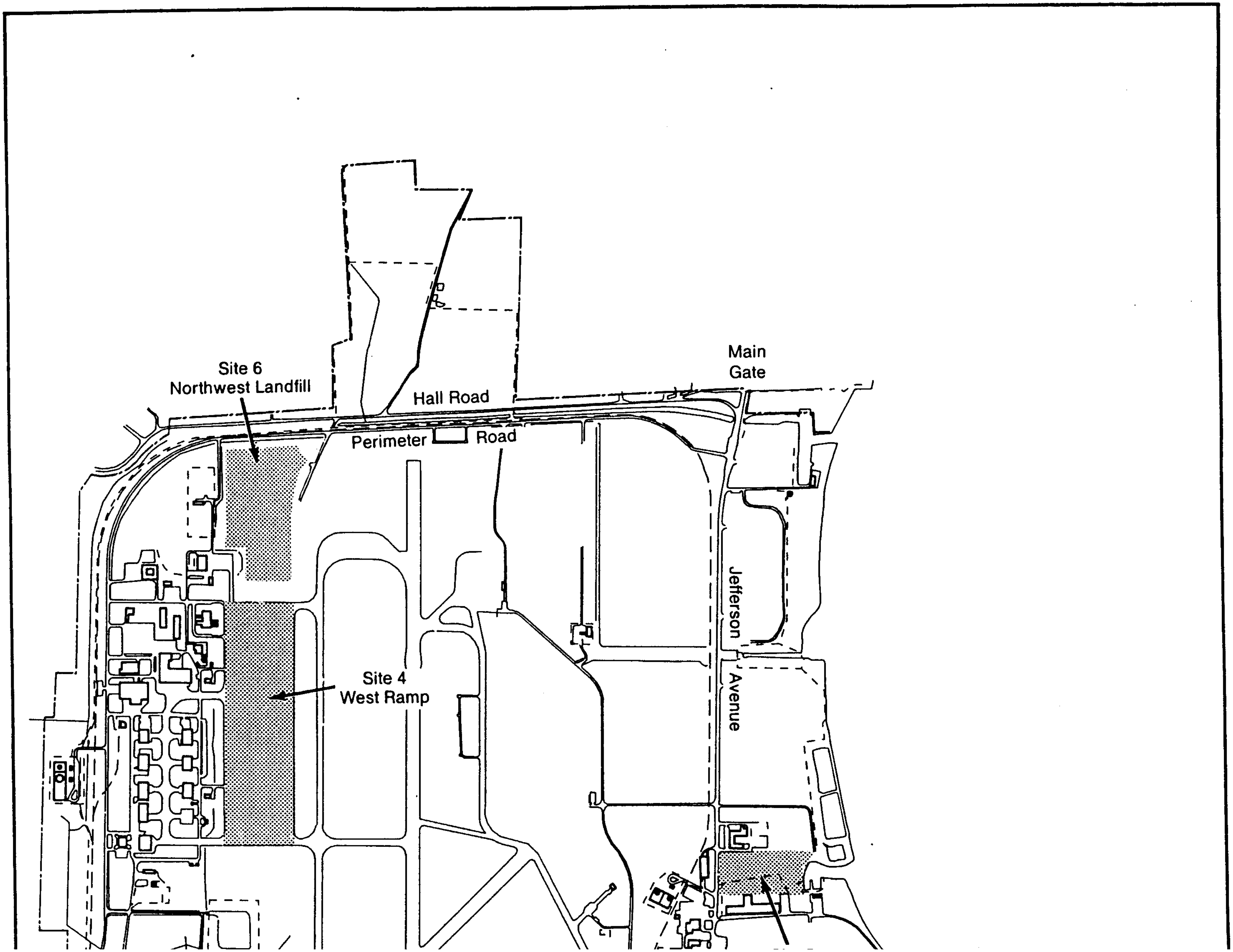


FIGURE 1-1 LOCATION MAP FOR SELFRIDGE ANGB



Site 6
Northwest Landfill
Hall Road
Main
Gate
Perimeter Road
Jefferson Avenue
Site 4
West Ramp

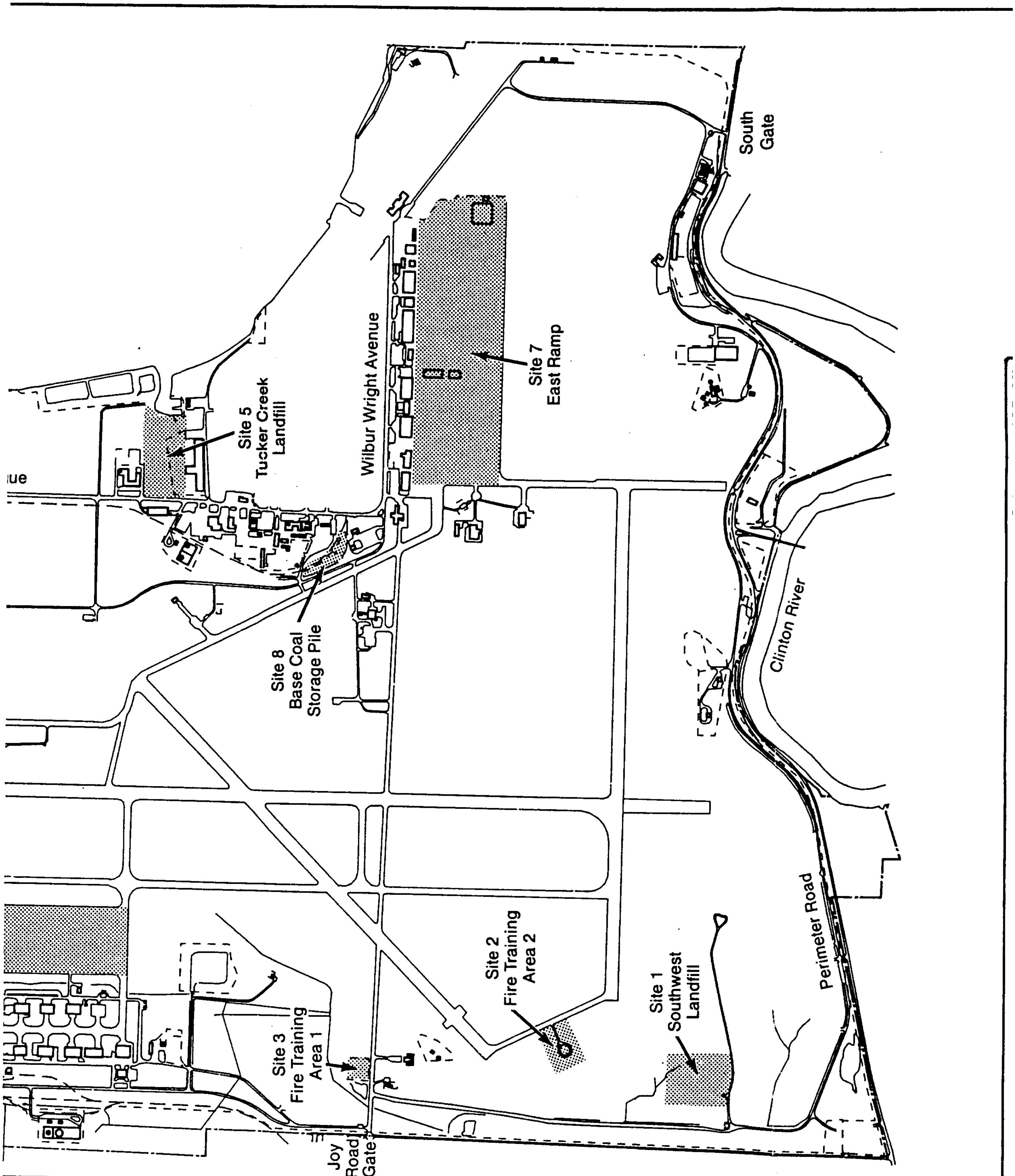

South Gate
Site 7
East Ramp
Wilbur Wright Avenue
Site 5
Tucker Creek
Landfill
ue
Site 8
Base Coal
Storage Pile
Clinton River
Perimeter Road
Site 2
Fire Training
Area 2
Site 1
Southwest
Landfill
Site 3
Fire Training
Area 1
Joy
Road
Gate

FIGURE 1-2

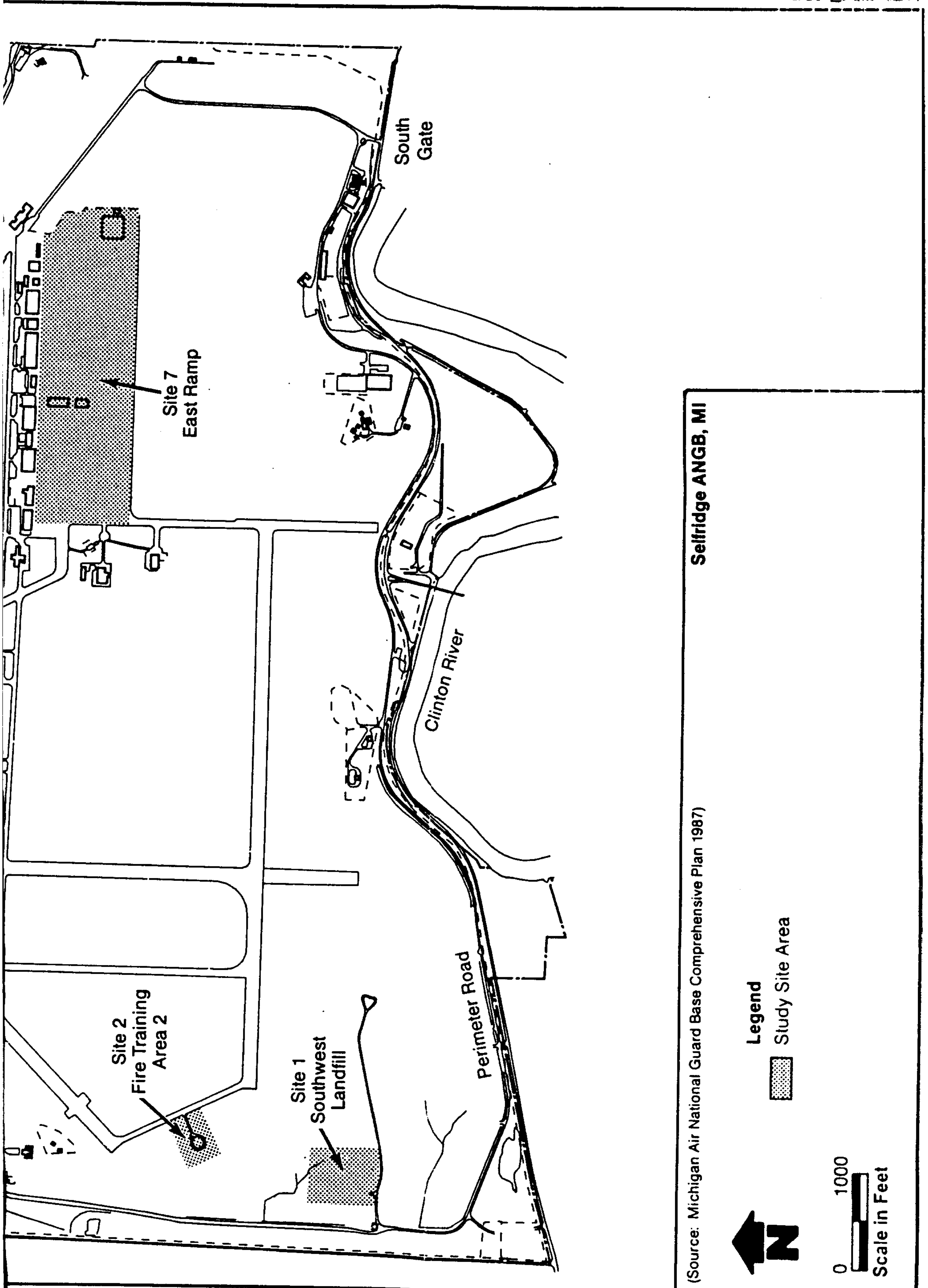


FIGURE 1-2 IRP STAGE 2 SITES AT SELFRIDGE ANGB

1.3.2 Waste Disposal Practices and Past Environmental Problems

1.3.2.1 Wastes Generated by Base Operations

Present and past Air National Guard and U.S. Air Force activities at Selfridge ANGB in support of training and operational missions have resulted in the generation of and the disposal of potentially hazardous wastes and materials. Those activities include aircraft maintenance, vehicle maintenance, grounds maintenance, electrical services, and paint shops. The aircraft maintenance operations have generated hazardous wastes in the form of contaminated fuels, hydraulic fluids, solvents, degreasers, and waste crankcase oil. Solvents used at Selfridge ANGB for aircraft maintenance have included carbon tetrachloride, trichloroethene (TCE), methyl ethyl ketone (MEK), acetone, and other halogenated and nonhalogenated organic compounds.

Vehicle maintenance has produced the same basic types of hazardous wastes as aircraft maintenance, including RCRA-listed materials such as chlorinated solvents, battery acid, as well as other materials such as ethylene glycol and crankcase oils.

Ground maintenance shops have also generated RCRA-listed materials such as chlorinated solvents, outdated pesticides, and empty pesticide containers. Other grounds maintenance wastes have included paint stripping sludges, small amounts of oils, and anti-scale compounds from boilers. Base electrical services could have generated wastes from maintenance or storage of transformers containing polychlorinated biphenyl (PCB)-contaminated oils; however, there are no records of spills or leaks of PCB-contaminated oils from transformers. On-base paint shops have used a wide variety of organic and inorganic paint removers and have produced wastes containing varnishes, lacquers, and lead-based paints.

1.3.2.2 Disposal Practices at Selfridge ANGB

Several different practices were used to dispose wastes generated from maintenance activities at the base. Waste oils were spread on dirt roads for dust control and/or taken off base by private contractors. Flammable liquids, including oils, solvents, contaminated fuels, and paints, were burned by the fire department during training exercises. Many types of solvents and degreasing compounds were disposed by dumping them into sinks or drains connected to storm or sanitary sewers, septic tanks, or by disposal in landfills located within the base boundaries (ENCOTEC, 1984).

All solid materials generated on base were disposed in base landfills. Rags, empty pesticide containers, and fuel tank bottom sludges were put into dumpsters that were then taken to the landfills (see Figure 1-2). All ordnance (spent propellant

cartridges, outdated munitions, firecrackers confiscated by law enforcement agencies, and any other items with explosive charges) were disposed by incineration in an oil-fired furnace. The remaining ash and metal casings were buried in a pit near Building 883, south of the small arms range.

During initial development and construction of Selfridge ANGB, sanitary sewage treatment consisted of septic tanks with sub-surface seepage fields. An Imhoff tank and drain field was constructed in the 1930s. In 1941 an activated sludge waste-water treatment plant (WWTP) was constructed and began operations. Plant effluent was discharged to the Clinton River. Sludge was anaerobically digested and dried on sludge beds, followed by land application on the present golf course site and over the area south of the North-South Instrument Runway (see Figure 1-2). The base discontinued use of the treatment plant in 1977 and now discharges to the Detroit Metropolitan Sewer System.

1.3.2.3 Past Environmental Incidents and Problems

In August 1979 high concentrations of DDT and chlordane were noted by a Michigan Department of Natural Resources (DNR) sampling of storm water drainage from the area south of the East-West Runway. That area had been used for land application of sludge contaminated with 5 gallons of DDT and 35 gallons of chlordane. The pesticides had been deposited in the sludge digester at the base WWTP by entomology shop personnel after being ordered to dispose of residual stocks of those materials. Disposal of outdated or unused pesticides into the sludge digester was a common practice. The base and Michigan DNR conducted laboratory analyses on soil, water, and sediment samples from pump stations (see Figure 1-2). The analytical results were tabulated in Appendix H of the Phase I Records Search Report (ENCOTEC, 1983). Based on the analytical results, the Michigan DNR determined that no environmental problem existed and, consequently, no further action was required.

1.3.3 IRP Phase I Investigation

ENCOTEC conducted a Phase I Problem Identification/Records Search at Selfridge ANGB in 1983. As part of the Phase I investigation, interviews were conducted with past and present base personnel familiar with past waste disposal practices. File searches were performed in order to identify base facilities that might have generated, handled, transported, and/or disposed potentially hazardous waste materials. Interviews were held with local, state, and Federal agencies, and site inspections were conducted at base facilities identified during the file search and interview process.

The records search and site examinations by ENCOTEC identified nine disposal sites at Selfridge ANGB which potentially contain

hazardous waste resulting from past disposal activities or significant fuel spills. Those sites were assessed using the Hazard Assessment Rating Methodology which ranks sites based on site characteristics, waste characteristics, potential for contaminant migration, and waste management practices. Two sites were determined to have a low potential for contaminant migration: the Sludge Application Area and Perimeter Road. Seven sites were determined to have a moderate potential for contaminant migration. Those seven sites are listed in Table 1-1 with their HARM scores and the standard site abbreviations used in this report.

ENCOTEC recommended further assessment of the seven sites with moderate potentials for contaminant migration.

1.3.4 IRP Phase II Stage 1 Investigation

1.3.4.1 Pre-Survey Report

WESTON conducted a pre-survey site visit of Selfridge ANGB on 19 April 1984. The site inspection was conducted by two WESTON personnel and a representative of USAFOEHL. During the site inspection, available maps, reports, and aerial photographs were reviewed with Base Bioenvironmental Engineering (BEE) and Civil Engineering (CE) personnel. A field inspection of all confirmed and suspected hazardous wastes sites was also conducted. WESTON completed the Pre-Survey Report and submitted it to USAFOEHL in May 1984. The report recommended some modifications to the proposed Technical Scope of Work for the Phase II Stage 1 investigations. Also, based on consultation with USAFOEHL personnel during the pre-survey and confirmed by WESTON's letter of 26 April 1984 to Mr. Emile Baladi, IRP Program Manager, the following modifications were made to the ranking of the hazardous waste sites by HARM scoring:

- The January 1984 Fuel Spill Site (POL Storage Site, priority 8) was incorporated into a zone within the West Ramp (priority 4).

- Priority for the Tucker Creek Landfill site was changed from 7 to 5. The Northwest Landfill site was dropped to priority 6, and the East Ramp dropped to priority 7.

The modification of priority for Tucker Creek Landfill was based on observations of the proximity of potentially hazardous materials in that landfill to the base school and playground (within several hundred feet) made during the pre-survey.

1.3.4.2 IRP Phase II Stage 1 Field Investigation

WESTON conducted field work for the Phase II Stage 1 Problem Confirmation/Quantification investigation from November 1984 to June 1985. The scope of the investigation included:

Table 1-1

IRP Phase II Stage 1 Investigation Sites, Selfridge ANGB, Michigan

Site Number	Site Name	Site Abbreviation	HARM Score
1	Southwest Landfill	SWLF	74.7
2	Fire Training Area 2	FTA-2	71.8
3	Fire Training Area 1	FTA-1	70.5
4	West Ramp	WRMP	66.4
5	Tucker Creek Landfill	TCLF	64.9
6	Northwest Landfill	NWLF	60.7
7	East Ramp	ERMP	59.4

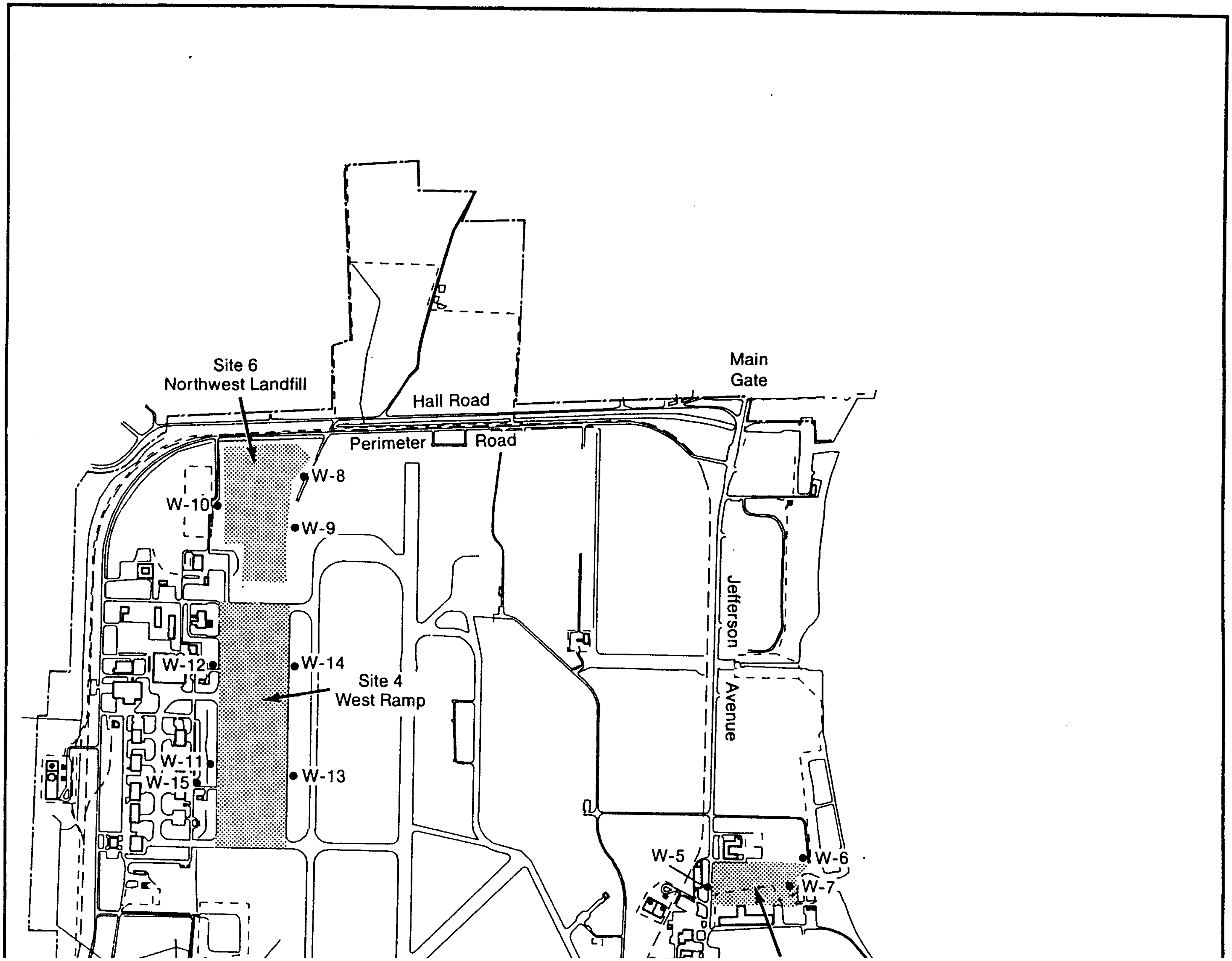
- Installing 25 groundwater monitor wells.
- Establishing five surface water sampling stations.
- Collecting and analyzing one round of water quality samples from all groundwater monitor wells and surface water stations.
- Collecting and analyzing 27 soil samples from 9 locations.
- Collecting three rounds of water level measurements from each of the newly installed monitor wells.

Figure 1-3 shows the locations of all Phase II Stage 1 sampling locations. The water samples (groundwater and surface water) were analyzed for total organic carbon (TOC), total phenols, chemical oxygen demand (COD), cadmium, chromium, copper, lead, nickel, zinc, total petroleum hydrocarbons (TPH), oil and grease (O&G), pH, temperature, specific conductance, and volatile organic compounds (VOCs). The soil samples were analyzed for VOCs, O&G, ignitability, and EP toxicity for arsenic, barium, cadmium, chromium, mercury, lead, selenium, and silver. All water and soil samples were analyzed by the WESTON Analytics Laboratory in Lionville, Pennsylvania.

1.3.4.3 Phase II Stage 1 Conclusions and Recommendations

The following findings resulted from the Phase II Stage 1 field program and chemical analyses of groundwater, surface water, and soils at Selfridge ANGB:

- Elevated concentrations of TOC were reported in all of the groundwater and surface water samples, with highest concentrations at SWLF, FTA-2, and NWLF.
- Elevated values of COD were detected in groundwater adjacent to each landfill.
- O&G and TPH concentrations were detected in all water samples at levels higher than the taste and odor threshold.
- Soluble copper and cadmium concentrations were detected at concentrations in excess of the Federal Primary Drinking Water standards in each of the landfills.
- Detectable concentrations of VOCs were found in 17 of 30 water samples and at 6 of the 7 sites.
- VOCs were also detected in each of the 27 soil samples submitted for analyses.


Site 6
Northwest Landfill
Hall Road
Main
Gate
Perimeter
Road
W-8
W-9
W-10
W-12
W-14
Site 4
West Ramp
W-11
W-15
W-13
Jefferson
Avenue
W-5
W-6
W-7

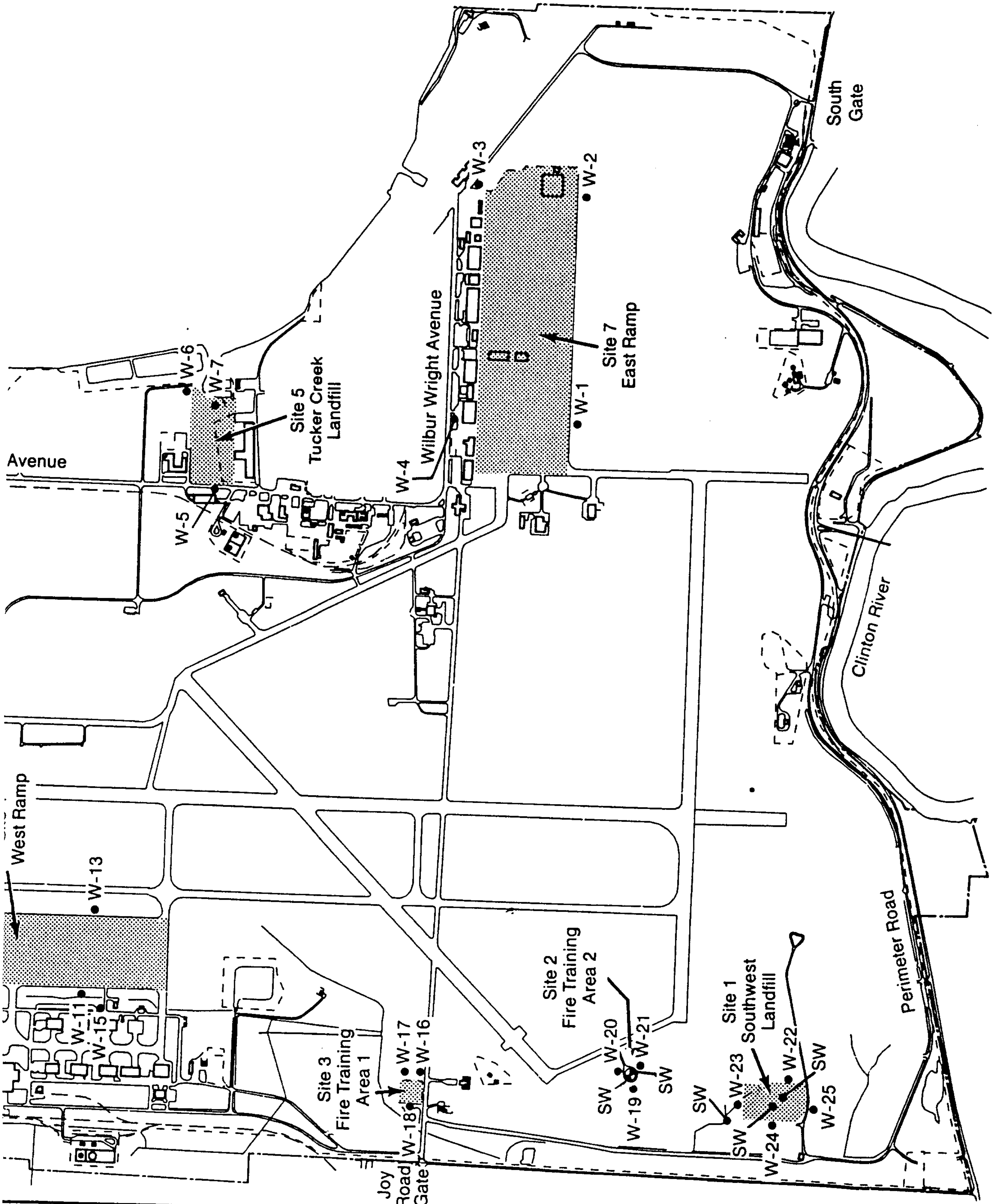


FIGURE 1-3 IRP PHA
LOCATIO

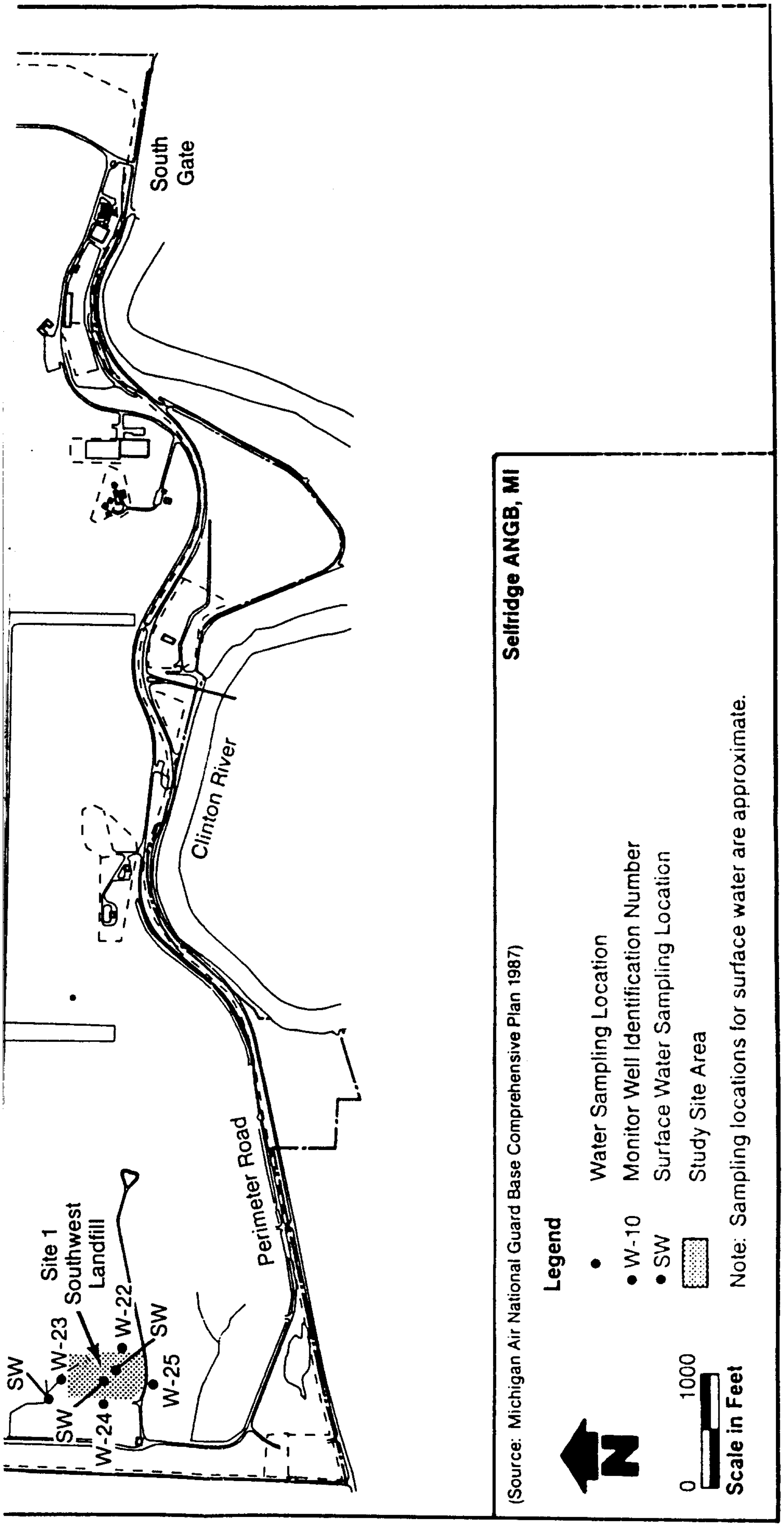


FIGURE 1-3 IRP PHASE II STAGE 1 SAMPLING LOCATIONS, SELFRIDGE ANGB

The following conclusions were drawn from these findings:

- Analysis of groundwater in the western portion of SWLF was indicative of a source of contamination in that area. Surface water sample analyses from that site suggest that leachate from SWLF affected the quality of the adjacent surface waters. It was presumed that the surface waters are discharged to the Clinton River.

- Contaminants in the water samples from FTA-2 indicate that the groundwater beneath that site has been contaminated. The low-permeability clays underlying that site have probably prevented severe subsurface contamination at that site.

- Subsurface contamination was present beneath and adjacent to NWLF, TCLF, and FTA-1. The water quality information at those sites was not sufficient to determine the nature, extent, or severity of contamination.

- The soils and groundwater beneath and adjacent to ERMP and WRMP exhibited moderate to high contamination levels. The analytical results suggest that the contaminants are those generally associated with fuel handling and storage activities.

- The elevated COD levels in the monitor wells around the base landfills suggest that the anaerobic conditions requisite for methane generation are present at each of those sites.

- It was suspected, on the basis of contamination in the upgradient well at TCLF, that some of the contaminants incorporated in the runoff from the ramps, runways, and industrial operation areas may be concentrated in the soils and groundwater near the drainage system catch basins.

- Findings concerning the physical setting of the sites indicate that, due to the presence of low-permeability clays beneath most of the base, extensive contaminant migration into deeper groundwater flow systems would be unlikely. Furthermore, potable uses of groundwater in the vicinity of Selfridge ANGB are limited. Shallow groundwater appears to be under an upward hydraulic gradient and to discharge locally to surface water bodies and storm drainage systems. The likely receptors for both shallow groundwater and surface water runoff would be the Clinton River and Lake St. Clair.

The Phase I Stage 2 Report recommended that all seven sites at Selfridge ANGB be classified as Category II sites requiring additional work to identify and quantify the extent of contamination. The additional investigative activities recommended

consisted of expanding the monitoring and sampling programs. The objectives of the additional studies were to determine the nature and extent of contamination by priority pollutant and petroleum hydrocarbon compounds and to evaluate the potential contaminant pathways -- specifically, shallow groundwater, surface water, and the hydraulic relationship between them.

1.3.5 Environmental Assessment by U.S. Army Corps of Engineers

In 1985 the U.S. Army proposed to construct a child development center on Selfridge ANGB in the area north of Building 970, between Jefferson Avenue and Lake St. Clair (see Figure 1-2), under the supervision of the U.S. Army Corps of Engineers (COE). The ongoing IRP investigations (Phase I Records Search - ENCOTEC, 1983) had identified the area south of Building 970 and adjacent to the proposed development center as the former TCLF and an area having a moderate potential for contaminant migration. Therefore, the U.S. Army Corps of Engineers, with consultation from the U.S. Army Environmental Hygiene Agency, conducted an environmental assessment to determine whether environmental conditions at the site of the proposed child development center could threaten the health of the future users of the center.

1.3.5.1 Initial Investigation by Clayton Environmental Consultants

A site characterization investigation was performed by Clayton Environmental Consultants, Inc., of Southfield, Michigan, under subcontract to Cummins & Bernard, Inc. of Ann Arbor, Michigan. Keck Consulting Services, Inc. of Williamston, Michigan, was retained to do the drilling and monitor well installation for this investigation.

In May 1986 Clayton Environmental was initially directed to:

- Drill three soil borings, two borings to 10 feet and one boring to 20 feet.
- Install 10-foot monitor wells with 5-foot screens in two of the soil borings.
- Sample soils in the soil borings at depths of 1 to 2 feet, 5 to 6 feet, and 9 to 10 feet and analyze for both inorganic and organic compounds.
- Sample the groundwater at both monitor well locations and analyze for VOCs.

The soils contained trace quantities of the pesticide DDT and associated compounds. Trace quantities of trichloroethane, toluene, tetrachloroethene, and methylene chloride were also detected. Arsenic, copper, lead, and nickel were detected in low concentrations (15 to 68 mg/kg). Phenol was detected in boring B-1 at concentrations from 58 to 93 mg/kg.

The groundwater from the two monitor wells contained only trace quantities of arsenic, copper, chromium, and lead and no detectable VOC concentrations.

1.3.5.2 Additional Investigations by Clayton Environmental Consultants

After the initial investigation, the results were evaluated by the COE in conjunction with the USAFOEHL Phase II Stage 1 IRP Report for Selfridge ANGB. It was decided that a more extensive examination of environmental conditions was necessary, especially in the disturbed area adjacent to and north of TCLF.

In October 1986 Clayton Environmental:

- Drilled soil borings in eight locations to depths of 30 feet below land surface (BLS).
- Installed four monitor wells with 5-foot screens at a depth of 29 feet in four of the soil borings.
- Sampled soils at the surface and at depths of 2, 5, and 10 feet and analyzed them for VOCs, pesticides/PCBs, TPH, and explosives.
- Sampled groundwater from all six COE monitor wells, and analyzed for metals, TPH, cyanide, sulfide, base-neutral and acid-extractable compounds (BNAs), VOCs, pesticides/PCBs, and explosives.

No explosives, PCBs, nor TPH were detected in the soils sampled in October 1986. Trace concentrations of pesticides were found in a sample from one boring. Methylene chloride (a common laboratory contaminant) was detected in soil samples taken from all borings at concentrations of 10 to 68 micrograms(ug)/kg. Tetrachloroethene, trichloroethene, and toluene were detected at trace concentrations (2 to 14 ug/kg). Metals were detected in concentration ranges commonly found in naturally occurring soils, according to Shacklette and Boerngen, 1984.

In the water samples, no VOCs, explosives, pesticides/PCBs, TPH, sulfide, nor cyanide were detected. No compounds on the U.S. EPA Hazardous Substance List (HSL) were detected in the BNAs analyses. None of the water samples contained a concentration of metals in excess of the U.S. or State of Michigan Primary Drinking Water Standards.

1.3.5.3 Conclusions of the Environmental Assessment

In their final report to the U.S. Army Corps of Engineers, which is included as Appendix C, Clayton Environmental Consultants drew the following conclusions:

- Groundwater flow is generally eastward and southward at Selfridge ANGB. The presence of storm sewers and the abnormally high Lake St. Clair level precluded obtaining definitive information on local groundwater flow.

- Metal concentrations found in soil were within levels found in naturally occurring soil in the region. No water samples contained metals above Federal or State Drinking Water Standards.

- VOCs detected could most likely be attributed to laboratory contamination.

- The pesticides found occurred in trace concentrations and were considered not significant.

- No regulated hazardous compounds were detected in the BNAs analyses.

After examining all the data, the U.S. Army Corps of Engineers made the determination that no chemical hazards were present on the site which would affect its use as the location of the proposed child development center. No indications were found that fill materials associated with TCLF extend to the site, and there was no evidence of groundwater contamination associated with TCLF in the vicinity of the proposed child development center. The construction schedule for the center anticipated a 15 September 1988 start, with a completion date of September 1989.

1.3.6 Clinton River Area of Concern

The governments of Canada and the United States of America signed the Agreement on Great Lakes Water Quality in 1972, the Great Lakes Water Quality Agreement of 1978, and the Phosphorus Load Reduction Supplement in 1983. Based on those agreements, the Great Lakes Water Quality Board of the International Joint Commission (IJC) defined the Clinton River an Area of Concern (AOC). Area of concerns are those sites identified by the Great Lakes Water Quality Board as significant past and/or present sources of pollutants to the Great Lakes.

The Clinton River is divided into two channels just east of Mt. Clemens. The first is an artificial spillway (Clinton Spillway) that runs southeast of Mt. Clemens and drains into L'anse Creuse Bay of Lake St. Clair. The second is the natural channel of the Clinton which meanders east along the axis of the peninsula just south of Selfridge ANGB and drains into Lake St. Clair. The Michigan Department of Natural Resources has defined the Clinton River AOC as both of these channels of the Clinton River. The source AOC is potentially the remainder of the Clinton River watershed.

The Great Lakes Water Quality Board Report (GLWQB, 1985) listed the following problems in the Clinton River AOC:

- Elevated fecal coliform bacteria concentrations.
- Elevated total dissolved solids concentrations.
- Contaminated sediments containing elevated levels of O&G and heavy metals.
- Degraded benthic macroinvertebrate community.

The sediments in the main channel of the Clinton River exceeded the heavily polluted U.S. EPA dredge spoil criteria for arsenic (>8 mg/kg), cadmium (>6 mg/kg), copper (>50 mg/kg), chromium (>75 mg/kg), lead (>60 mg/kg), nickel (>50 mg/kg), zinc (>200 mg/kg), PCBs (>10 mg/kg), and O&G (>2,000 mg/kg). In addition, high levels of total phthalates and polynuclear aromatic hydrocarbons (PAHs) were found in the sediments of the Clinton River just south of Selfridge ANGB.

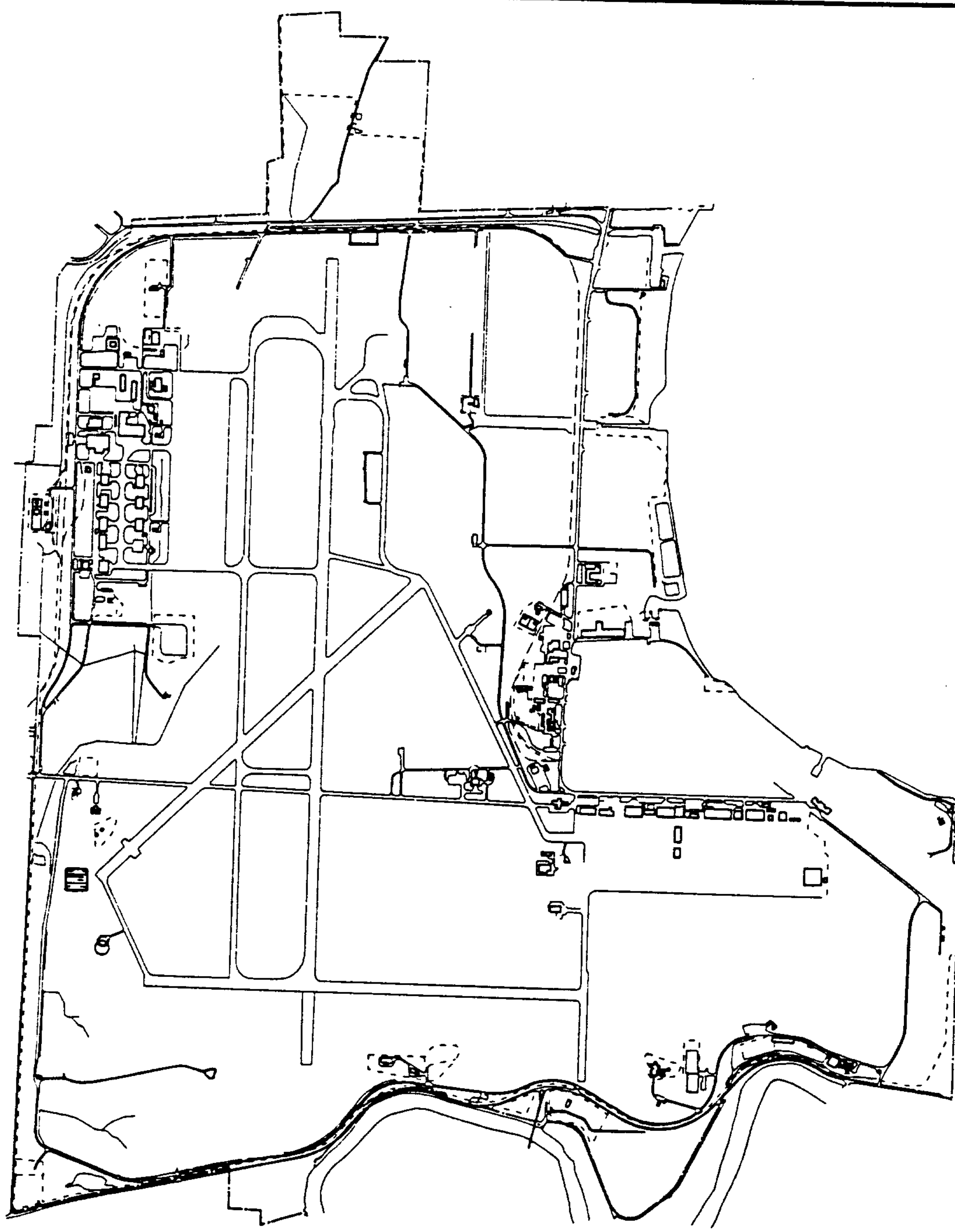
Problems in the natural channel of the Clinton River (designated as Section 1) have historically been attributed to upstream point sources, urban runoff, and the Mt. Clemens Wastewater Treatment Plant and Combined Sewer Overflow (CSO) loadings. However, Michigan DNR, in their January 1988 draft report on the Clinton River AOC, cited the Selfridge ANGB landfills as an emerging problem for the natural channel of the Clinton River. Further analysis by Michigan DNR on any previous, present, or potential impact by the Selfridge ANGB landfills on the water and sediment quality of the Clinton River AOC will depend, in part, on the findings of the IRP Stage 2 report.

1.3.7 Additional Fire Training Area

During the current IRP Stage 2 study, examination of a topographic map of Selfridge ANGB, dated 1975, indicated the presence of a fire training area not identified during the historical records search nor the IRP Phase II Stage 1 study. The suspected fire training area is located west of the southwestern end of Taxiways C and M, north of FTA-2 (see Figure 1-4).

The period of active use and the location of what is hereby designated as Fire Training Area 3 (FTA-3) was confirmed by aerial photographs from various sources, personal communication with Colonel Robert Stone, USAF (Retired), Curator of the Selfridge ANGB Museum, and a site visit by WESTON personnel. FTA-3 is clearly visible on the Macomb County Soil Survey map that was prepared using aerial photographs from 1955 and 1964. Aerial photographs from the Macomb County Planning Commission taken in 1964 and 1972 appear to show that FTA-3 was active in 1964 and inactive in 1972. Col. Stone has estimated the active periods for the three fire training areas as:

WESTON



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

0 1000

Scale in Feet

Legend

FTA-3

FIGURE 1-4 LOCATION OF FIRE TRAINING AREA 3 (FTA-3), SELFRIDGE ANGB, MI

- Fire Training Area 1: pre-1959
- Fire Training Area 2: 1964 to present
- Fire Training Area 3: 1959 to 1964

These estimates were made by Col. Stone based upon his own knowledge of Selfridge ANGB and from inquiries he made to former or current base personnel.

Final confirmation of the existence of FTA-3 was made by WESTON personnel during a site visit in August 1988. FTA-3 was described as being similar to FTA-2, consisting of a bermed area with a depression in the center. The area around the berm has been mowed by the Base Roads and Grounds Maintenance Department.

1.4 SITE DESCRIPTIONS

The IRP Stage 2 investigation examined eight sites at Selfridge ANGB. The first seven sites were those investigated during the Phase II Stage 1 study (see Table 1-1) and recommended for additional study. The eighth site (Base Coal Storage Pile) was added at the request of Selfridge ANGB staff. The list of IRP Stage 2 investigation sites is given in Table 1-2, and locations are shown in Figure 1-2.

The following subsections present summaries of the information available from earlier investigations and describe site histories and environmental settings on a site-by-site basis.

1.4.1 Site 1: Southwest Landfill (SWLF)

Site Description:

SWLF was used in the past to dispose residential and industrial waste. The site is located in the southwestern corner of the base (see Figure 1-5). Currently, the site is used for disposing demolition and landscape debris and ash from the base coal-fired power plant.

Size: 40 acres

Period of Use: 1970 to present

Past Practices:

SWLF operated from 1970 to 1978 under Michigan Public Act 87, as amended, to dispose approximately 5,900 tons per year of residential and industrial waste. Typical wastes brought to the site were demolition materials, residential waste, solvents (trichloroethene, carbon tetrachloride, methyl ethyl ketone), paint strippers and thinners, and waste oils. Clayey sand was used for daily cover.

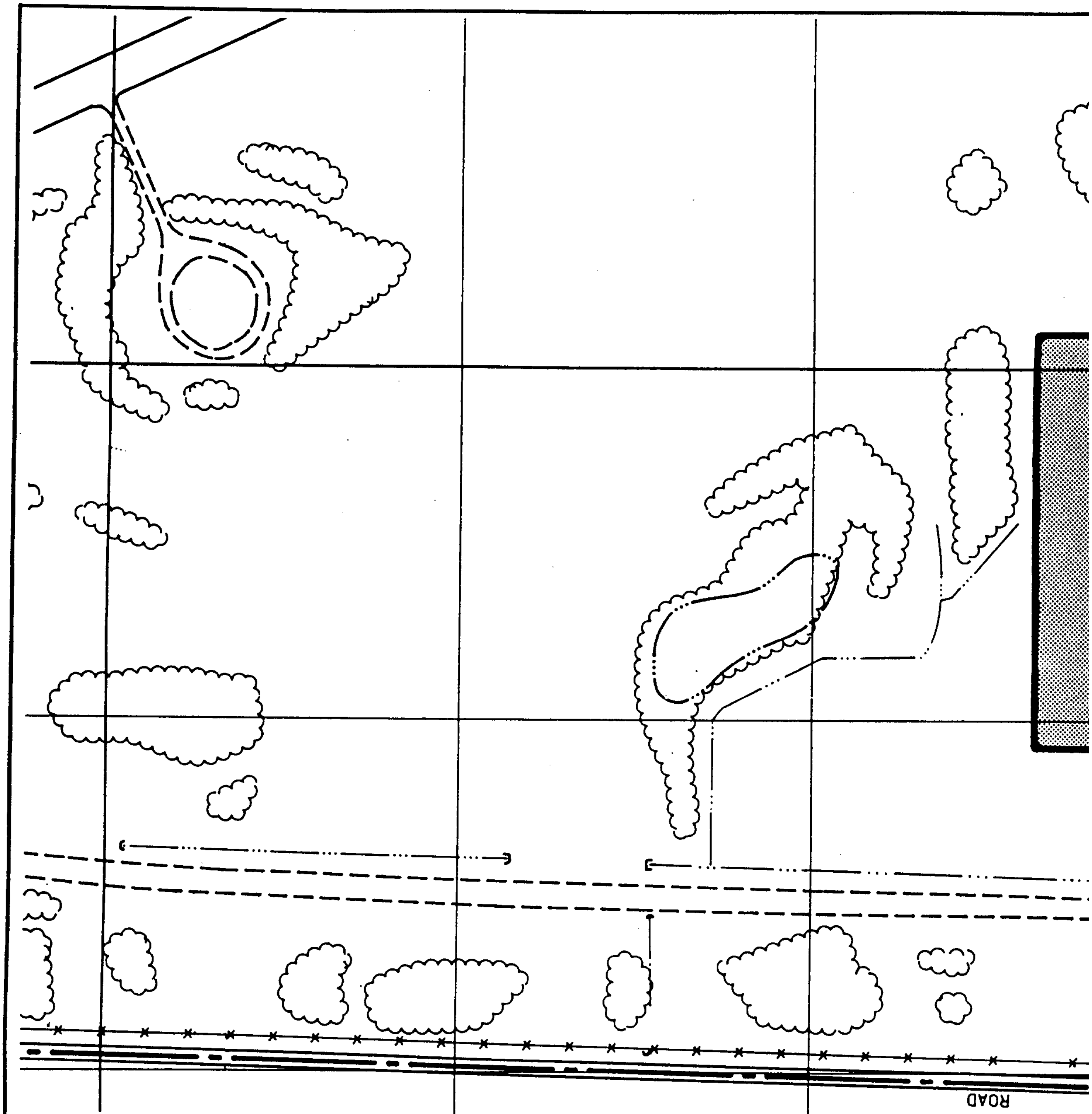
Summary of Phase II Stage 1 Investigation:

The Phase II Stage 1 investigation at SWLF consisted of installing four groundwater monitor wells (W22 through W25)

Table 1-2

IRP Stage 2 Investigation Sites,
Selfridge ANGB, Michigan

Site Number	Site Name	Site Abbreviation
1	Southwest Landfill	SWLF
2	Fire Training Area 2	FTA-2
3	Fire Training Area 1	FTA-1
4	West Ramp	WRMP
5	Tucker Creek Landfill	TCLF
6	Northwest Landfill	NWLF
7	East Ramp	ERMP
8	Base Coal Storage Pile	BCSP



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

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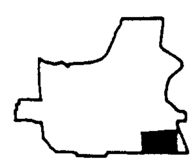
Study Site Area



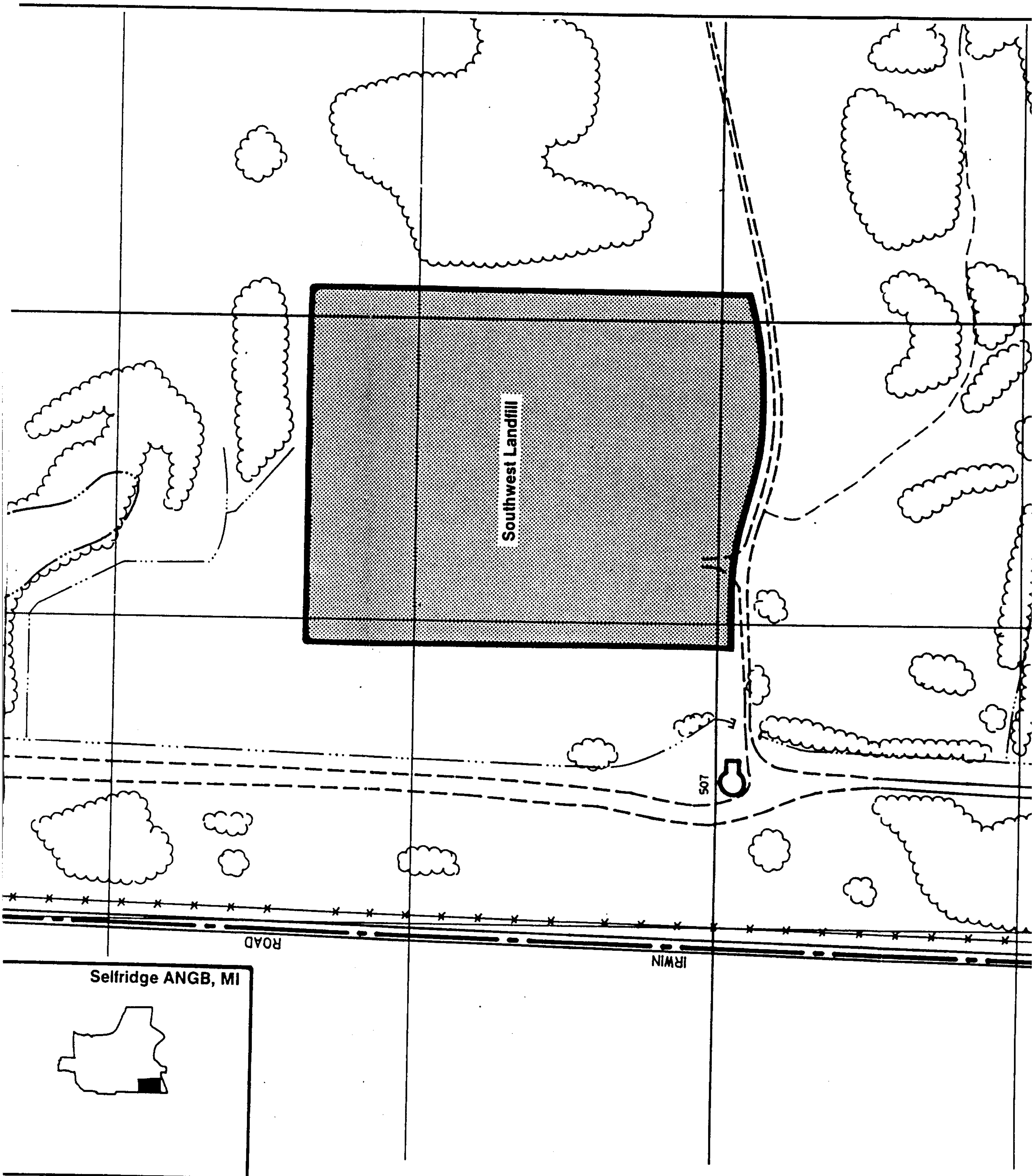


FIGURE 1-5

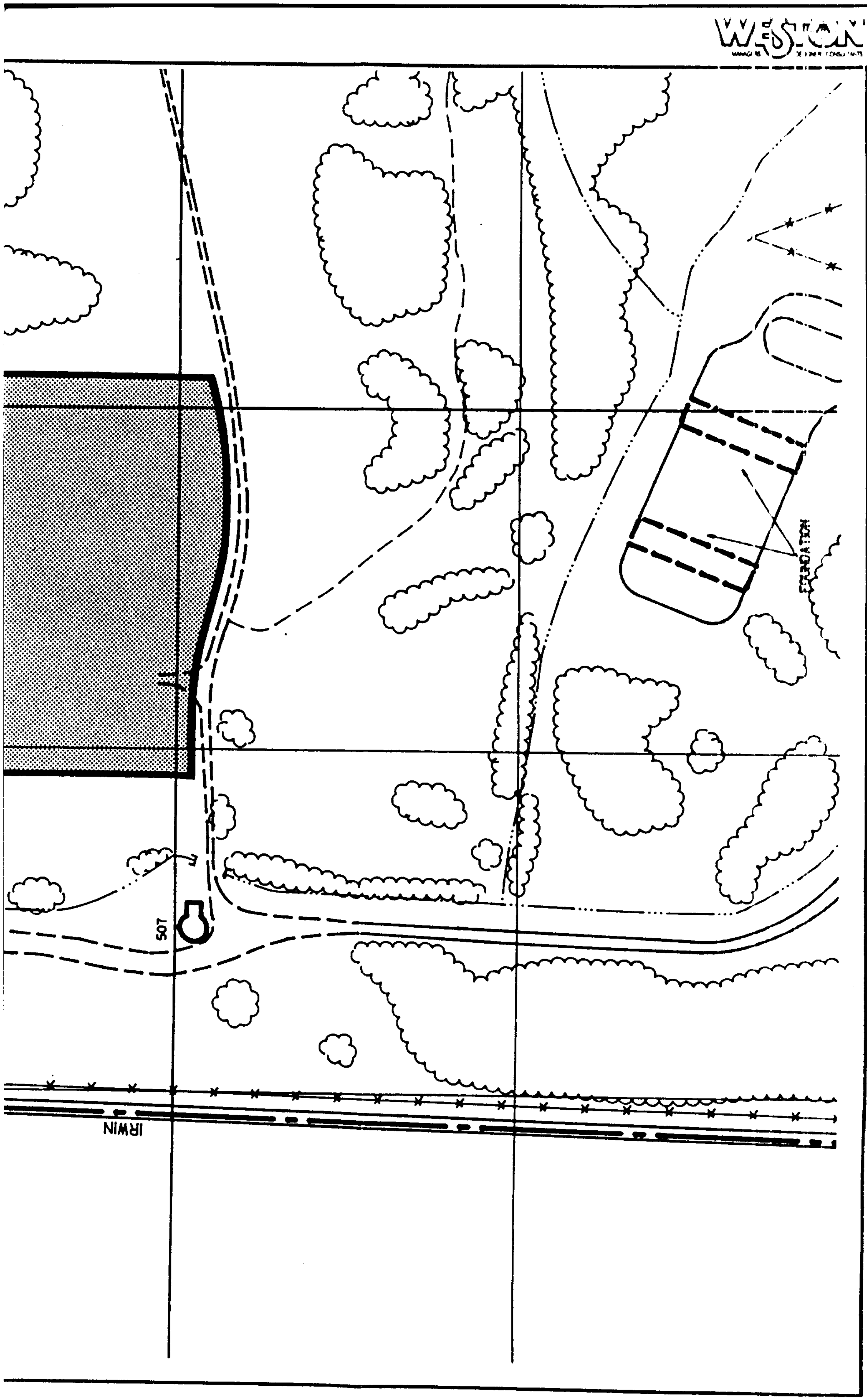


FIGURE 1-5 SOUTHWEST LANDFILL (SWLF) SITE MAP, SELFRIDGE ANGB

screened into the upper 25 feet of the unconsolidated formation. Three surface water samples were obtained, two from ponded areas in the middle of the landfill and one from a ravine located to the northwest of the site. The groundwater and surface water samples were analyzed for VOCs, TOC, O&G, COD, total phenolics, and heavy metals. The results of those analyses are summarized in the following matrix.

Medium Sampled	Parameter Detected	Range of Concentration	
Groundwater	Benzene	<4.0 - 51.0	ug/L
	trans-1,2-Dichloroethene	<2.0 - 71.0	ug/L
	Ethylbenzene	<2.0 - 44.0	ug/L
	Methylene chloride	<3.0 - 84.0	ug/L
	Toluene	<2.0 - 52.0	ug/L
	Trichloroethene	<2.0 - 6.7	ug/L
	Vinyl chloride	<4.0 - 45.0	ug/L
	TOC	6.2 - 13.5	mg/L
	Phenolics	<5.0 - 435	ug/L
	COD	32 - 3,150	mg/L
	Cadmium	<10.0 - 19	ug/L
	Copper	<10.0 - 1,100	ug/L
	Lead	<10.0 - 20	ug/L
	TPH	0.4 - 113	mg/L
	O&G (W23 only)	1.38	mg/L
	pH (units)	6.2 - 7.2	
	Specific conductance	1,190 - 7,010	micro-mho/cm
Surface water	TOC	6.8 - 11.5	mg/L
	Phenolics	<5.0 - 47	ug/L
	COD	27.0 - 42.0	mg/L
	Copper	13 - 34	ug/L
	O&G	<0.1 - 0.2	mg/L

The Phase II Stage 1 investigation borings encountered alluvial deposits of gray to brown moderately to poorly sorted clays, silts, sands, and gravel from the Clinton River meander belt. Saturated soils were encountered within 5 to 10 feet below land surface. Groundwater occurs under water table and/or under semiconfined conditions at SWLF. Based on the Phase II Stage 1 findings, the hydraulic gradient in the southwestern corner of the base is to the northeast at approximately 0.005 feet per foot. This suggests that the Clinton River may be a source of recharge to the shallow aquifer beneath the southern portion of the base. A steeper hydraulic gradient north of SWLF appears to indicate that the permeability of the shallow unconsolidated formation decreases northward from the Clinton River meander belt, moving from the meander belt into lacustrine silts and clays.

1.4.2 Site 2: Fire Training Area 2 (FTA-2)

Site Description:

FTA-2 is located in the southwestern part of the base, north of SWLF, and west of Taxiway C (see Figure 1-6). The site has been used to conduct fire training exercises since 1964.

Size: 4 acres

Period of Use: 1964 to present

Past Practices:

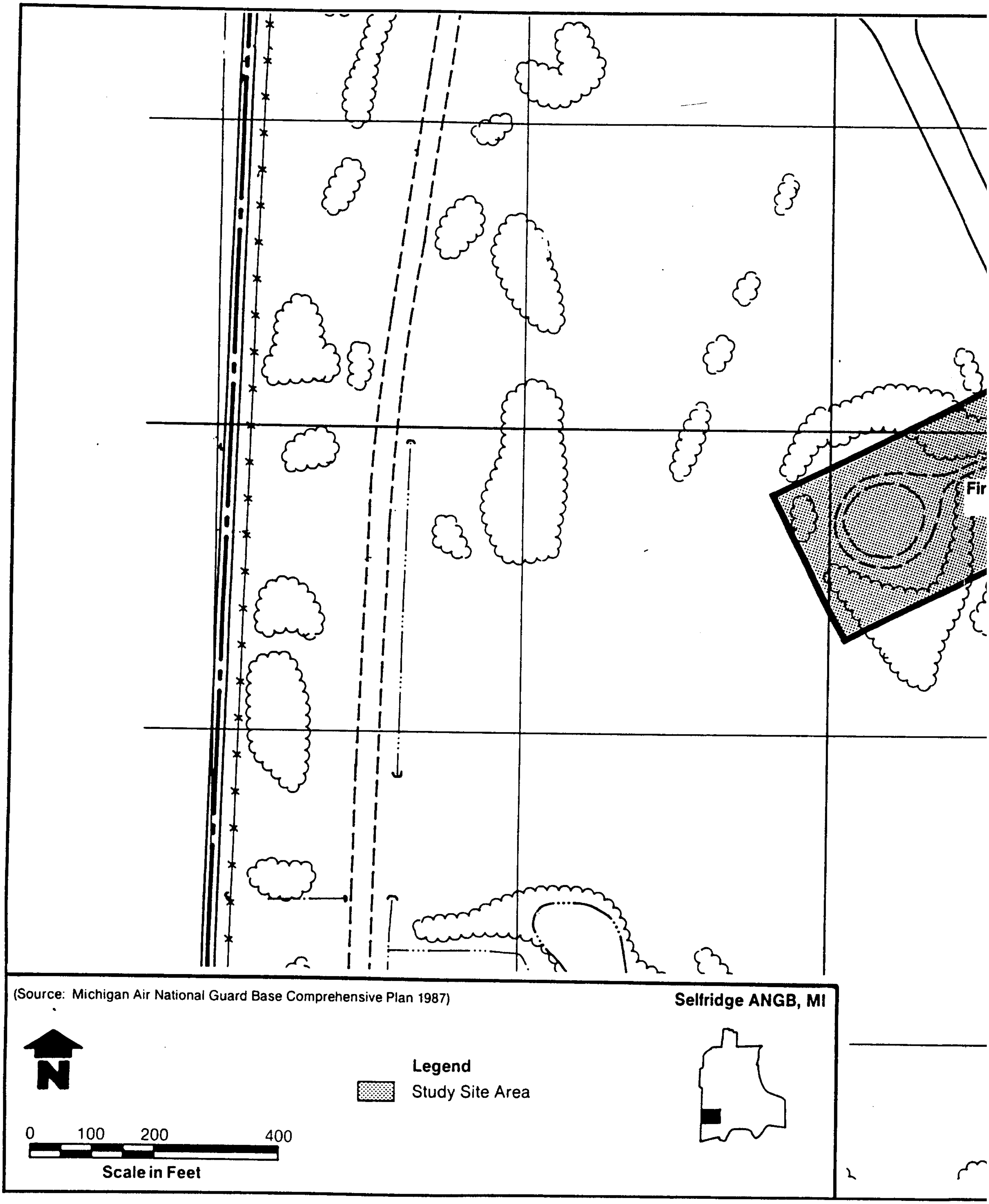
FTA-2 was excavated to 1 to 1.5 feet BLS and was filled with broken concrete and demolition materials. No liner was installed prior to backfilling the pit excavation. Eight to 12 training fires are conducted each year. From 1964 until the present the fire department used JP-4 or AVGAS containing less than 10 percent contaminants. Approximately 350 to 500 gallons of JP-4 are pumped into the pit, ignited, and then extinguished during a typical training exercise. Approximately 25 percent of the fuel remains as residue.

Summary of Phase II Stage 1 Investigation:

The Phase II Stage 1 investigation at FTA-2 consisted of installing and sampling three monitor wells (W19, W20, and W21) and collecting surface water from two ponded water locations. The samples were analyzed for VOCs, TOC, phenols, and TPH. The results of those analyses are summarized in the following matrix.

Medium Sampled	Parameter Detected	Range of Concentration
Groundwater	Trichloroethene	<2.0 - 2.4 ug/L
	TOC	8.5 - 37.5 mg/L
	Phenolics	7 - 17 ug/L
	TPH	1.1 - 2.4 mg/L
	pH (units)	7.1 - 7.5
	Specific conductance	1,580 - 8,600 micromho/cm
Surface water	Benzene*	<4.0 - 16.0 ug/L
	Chloroform*	5.6 - 6.0 ug/L
	1,2-Dichlorobenzene*	14.0 ug/L
	Methylene chloride*	8.5 - 13.0 ug/L
	Toluene*	5.5 - 34.0 ug/L
	1,1,1-Trichloroethane*	<2.0 - 4.9 ug/L
	Trichloroethene*	3.0 ug/L

*Recommended holding time exceeded.



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(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
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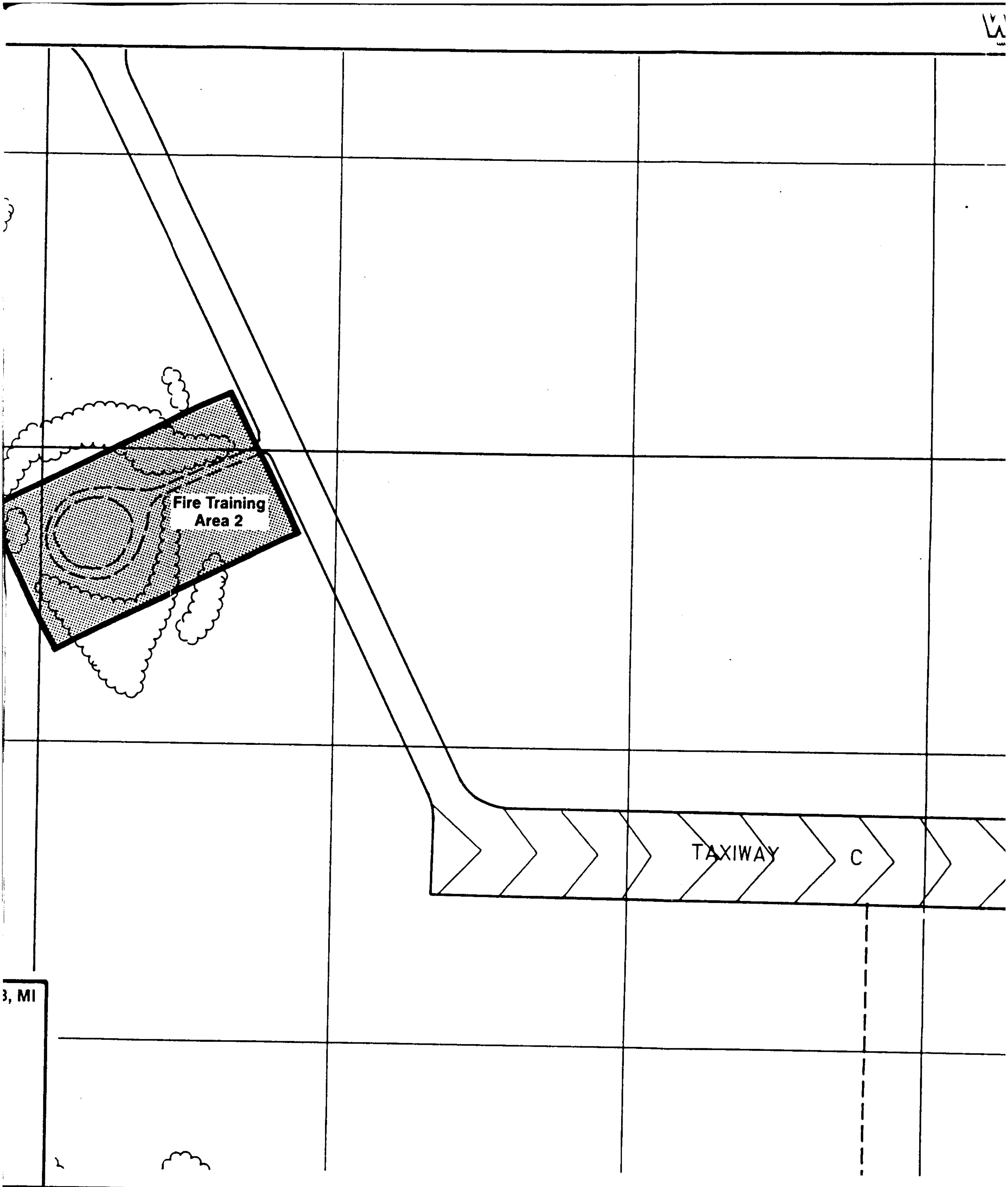


FIGURE 1-6 FIRE TRAINING ARE
SITE MAP, SELFRID

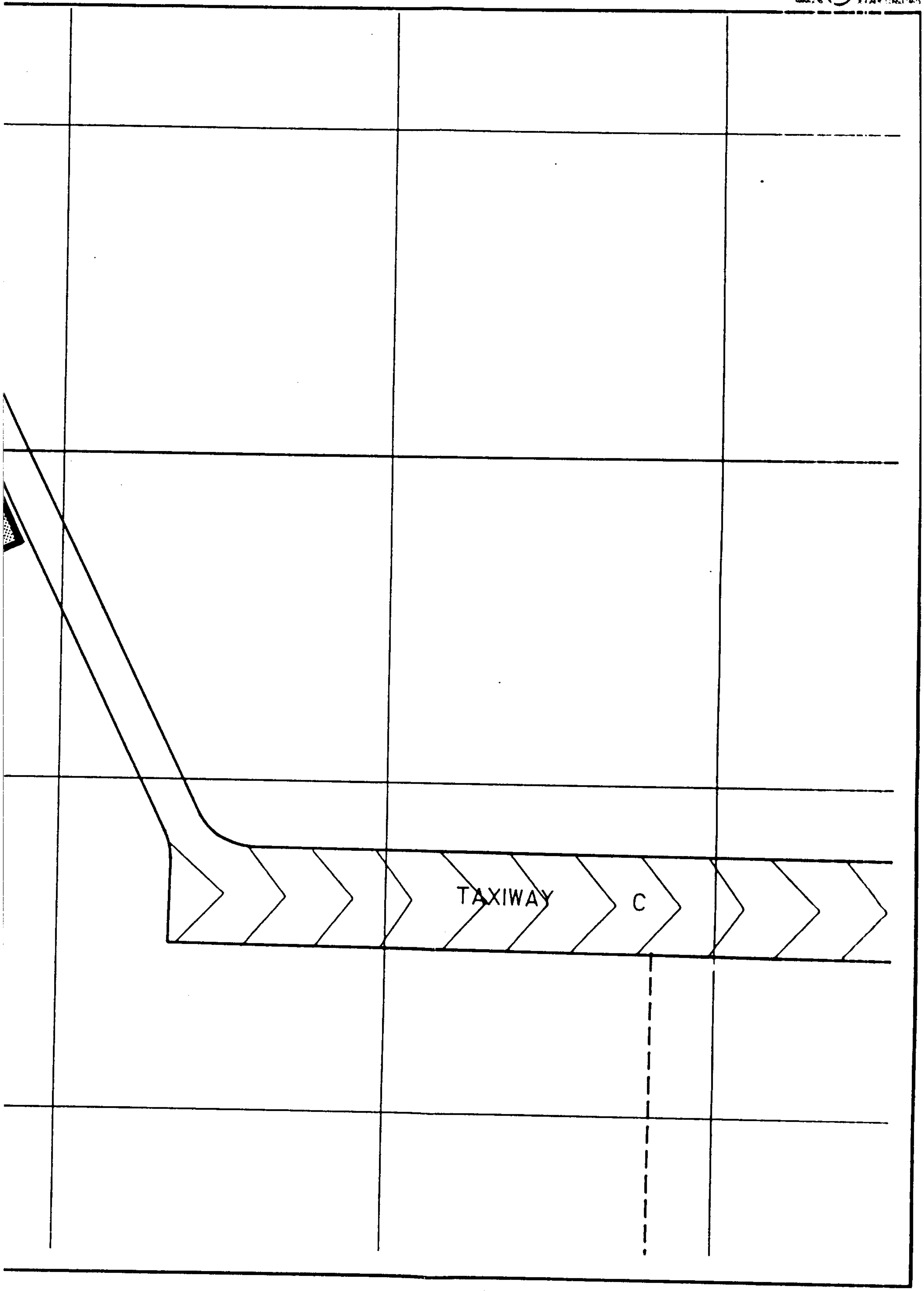


FIGURE 1-6 FIRE TRAINING AREA 2 (FTA-2) SITE MAP, SELFRIDGE ANGB

Medium Sampled	Parameter Detected	Range of Concentration
Surface water (continued)	Trichlorofluoromethane*	<3.0 - 6.0 ug/L
	TOC	93.0 - 165.0 mg/L
	Phenolics	96 - 147 ug/L
	TPH	4.5 - 69.0 mg/L

* Recommended holding time exceeded.

The Phase II Stage 1 investigation found thin silty sand lenses interbedded with lacustrine silts and clays in the subsurface under FTA-2. The saturated materials (the thin silty sand lenses) occur at a depth of 12 to 15 feet BLS. Static water levels are generally within 2.5 to 7.5 feet of land surface, indicating confined conditions and a significant upward hydraulic gradient. The lateral hydraulic gradient in the vicinity of FTA-2 was found to be consistent with that of SWLF at approximately 0.006 feet per foot to the northeast. Northeast of FTA-2, the hydraulic gradient was interpreted to flatten and change orientation to the east.

1.4.3 Site 3: Fire Training Area 1 (FTA-1)

Site Description:

FTA-1 is located north of FTA-2, near Building 567, in an unlined pit backfilled with gravel (see Figure 1-7). The pit was used for fire training exercises until 1959. The area is currently surrounded by a security fence and is used as an unpaved parking area.

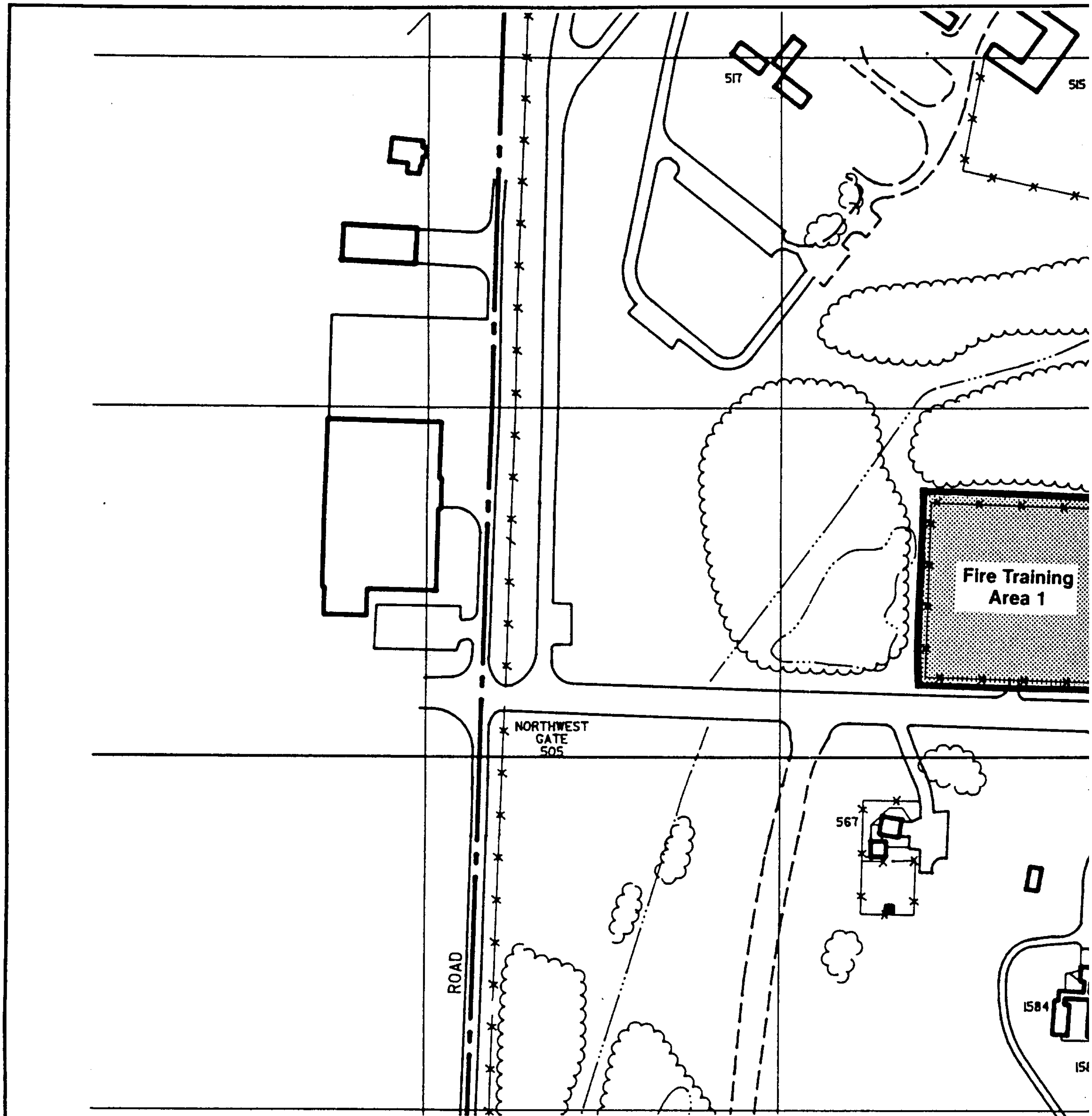
Size: 0.25 acres   Period of Use: 1952 to 1959

Past Practices:

From 1952 until 1959, the fire department used ignited waste flammables (e.g., JP-4, solvents, strippers, and thinners) in the pit for fire training exercises. The waste flammables were stored on-site in drums between fire training exercises. It is assumed that FTA-1 configuration and construction were similar to that of FTA-2, although no drawings exist of the facility. It is also assumed that the burn efficiency of the training exercises was similar (approximately 75 percent of flammables consumed per burn).

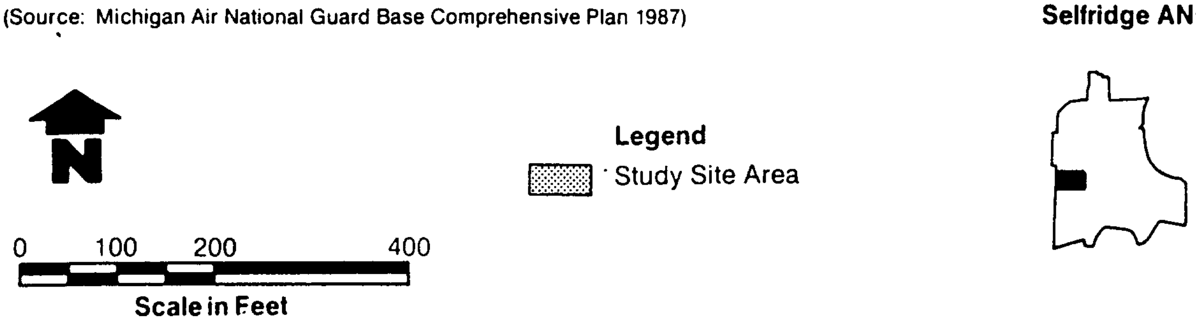
Summary of Phase II Stage 1 Investigation:

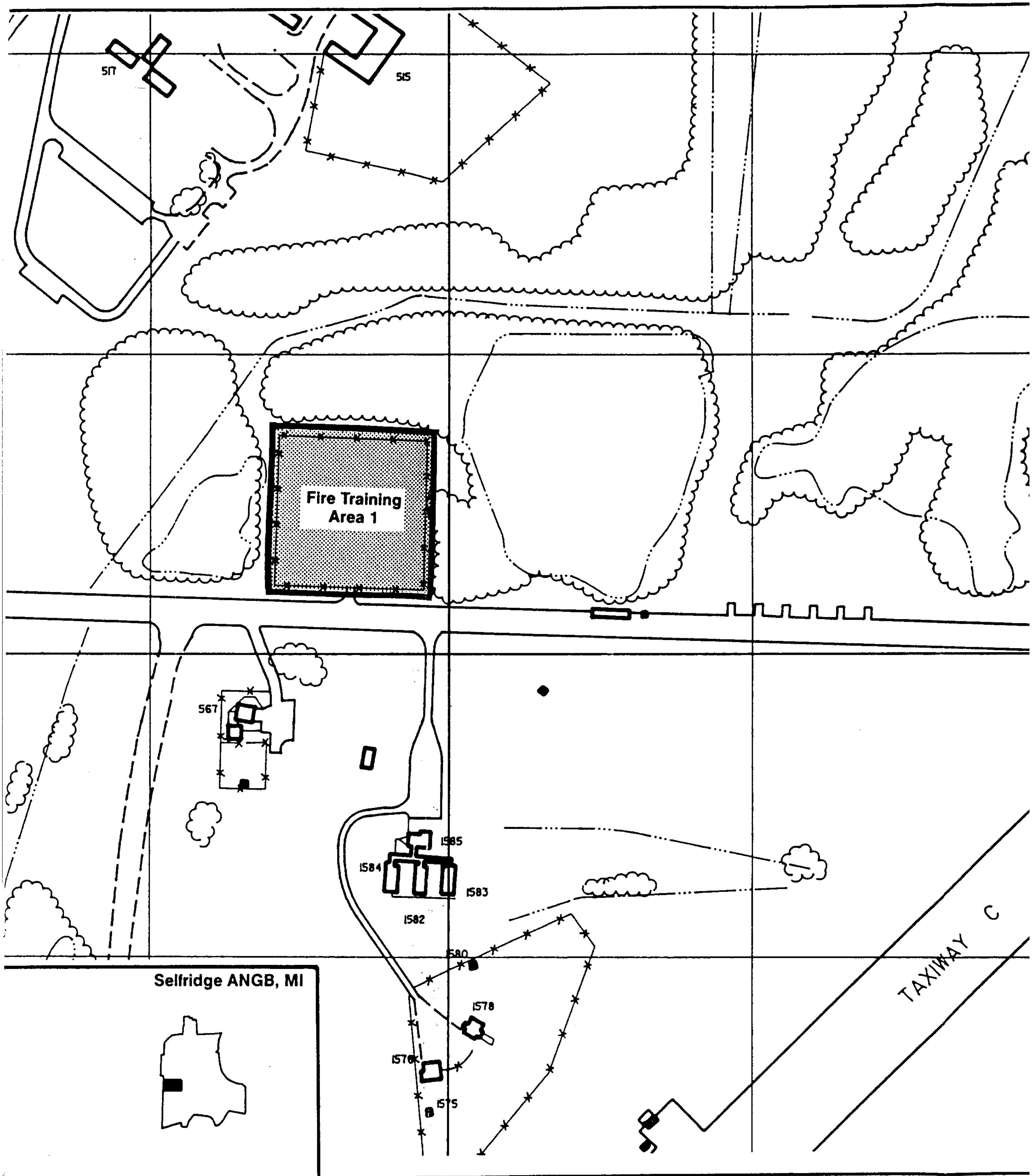
The Phase II Stage 1 field investigation consisted of installing three groundwater monitor wells into the unconsolidated



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

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TAXIWAY C
Selfridge ANGB, MI

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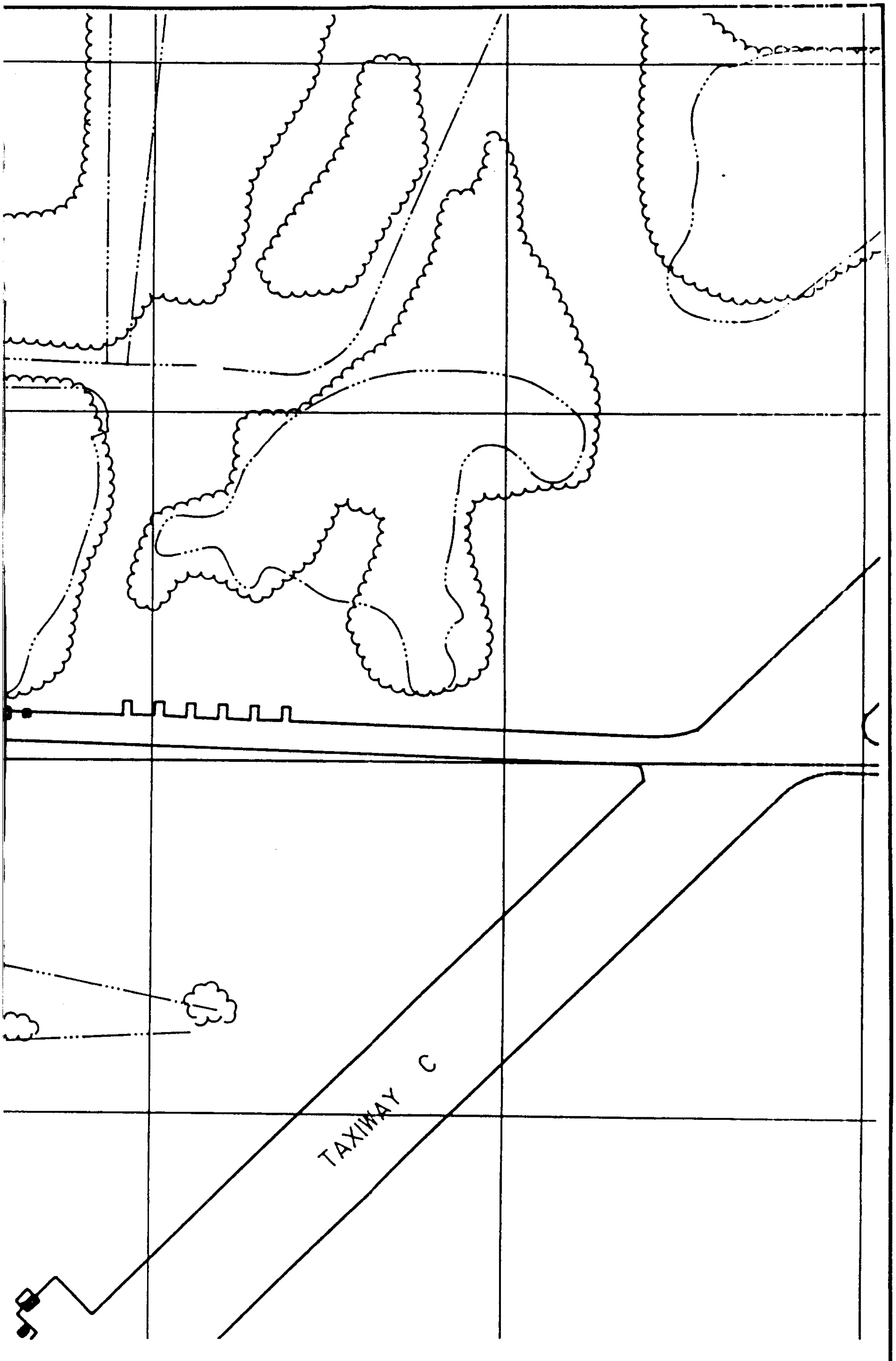


FIGURE 1-7 FIRE TRAINING AREA 1 (FTA-1) SITE MAP, SELFRIDGE ANGB

sediments beneath FTA-1. The wells were sampled and were analyzed for VOCs, TOC, TPH, and phenolics. The results of those analyses are summarized in the following matrix.

Medium Sampled	Parameter Detected	Range of Concentration
Groundwater	TOC	4.3 - 5.7 mg/L
	Phenolics	<5.0 - 7 ug/L
	TPH	0.3 - 1.0 mg/L
	pH (units)	6.7 - 7.2
	Specific conductance	1,080 - 1,110 micro-mho/cm

The Phase II Stage 1 subsurface drilling found lacustrine silts and clays. Groundwater occurs under confined conditions at depths greater than 10 to 12 feet BLS. The hydraulic gradient was found to be approximately 0.004 feet per foot to the southeast in the vicinity of FTA-1. The hydraulic gradient was interpreted to flatten north and southeast of FTA-1.

1.4.4 Site 4: West Ramp (WRMP)

Site Description:

WRMP is a flightline apron area located in the northwestern portion of the base. WRMP is bounded on the north by NWLF, on the east by the airfield, on the south by an undeveloped wooded area, and on the west by aircraft hangars and support buildings (see Figure 1-8). The ramp is utilized for aircraft parking, maintenance, and fueling.

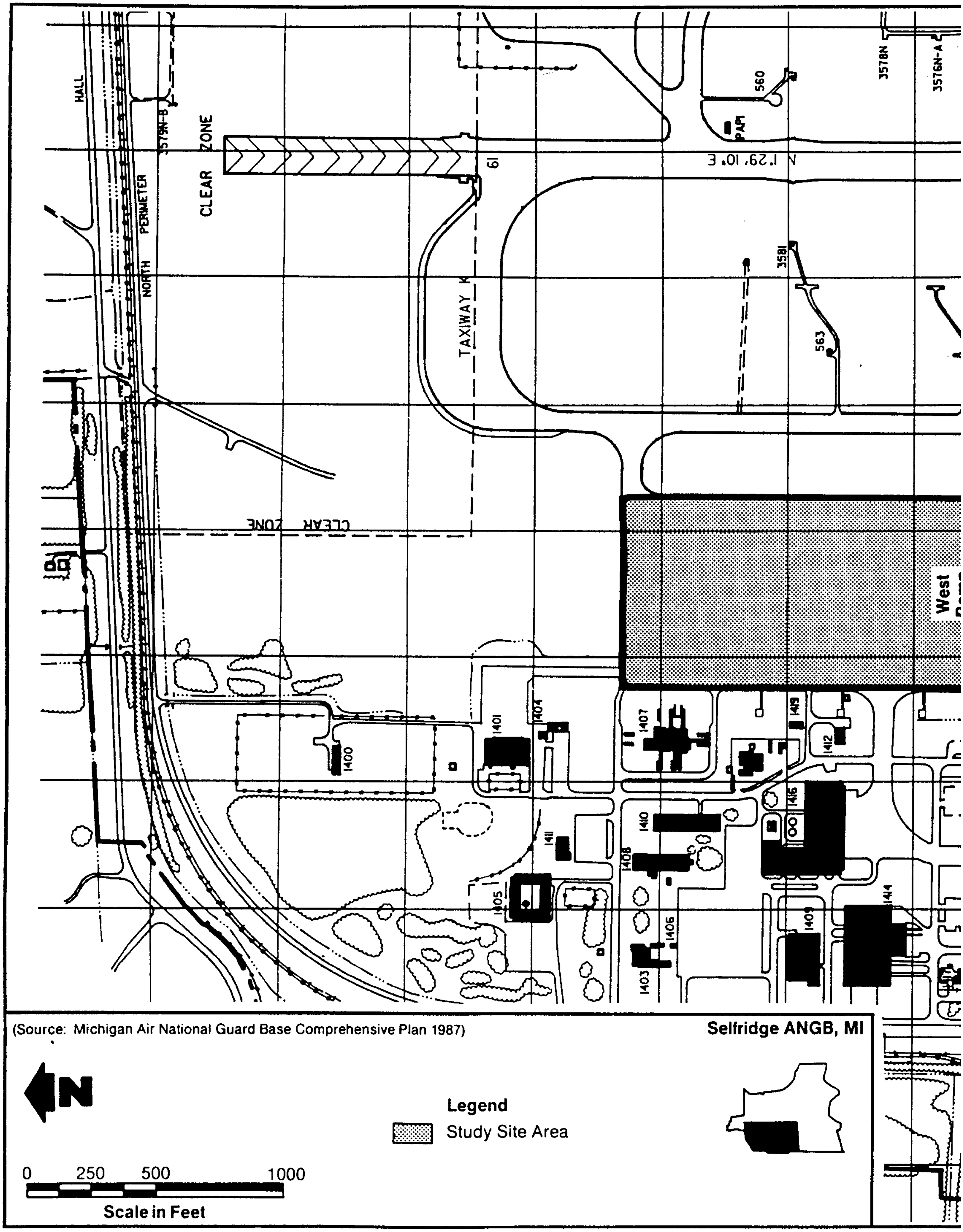
Size: 85 acres Period of Use: 1922 to present

Past Practices:

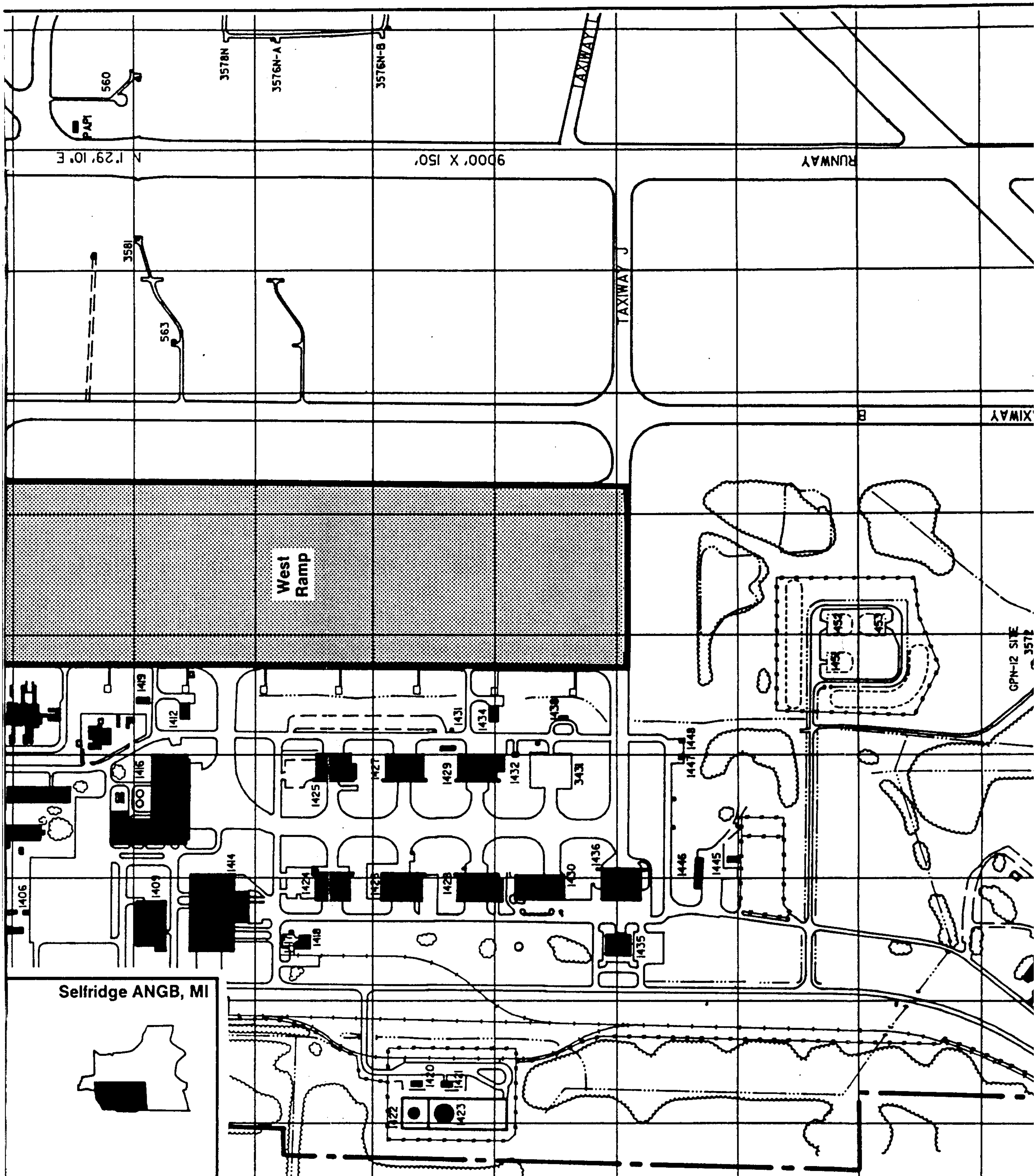
WRMP is used for aircraft parking, maintenance, and fueling. Two fuel spills involving a total of over 3,000 gallons of JP-4 have reportedly occurred in the southwestern portion of the aircraft parking area, near a buried fuel line pump station. Both spills were related to pumping equipment malfunctions. Remedial cleanup activities were performed by base personnel, but the bulk of the fuel drained into a landscaped depression between the aircraft hangars and the parking area. Base personnel have noted fuel odors in this area during extensive wet periods.

Summary of Phase II Stage 1 Investigation:

Field investigations during the Phase II Stage 1 study included installing five groundwater monitor wells into the unconsoli-



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)



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3576N-A
3576N-B
TAXIWAY
N 1°29' 10" E
9000' X 150'
RUNWAY
3581
563
TAXIWAY J
TAXIWAY
B
West Ramp
GPN-12 SITE
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Selfridge ANGB, MI

FIGURE 1-

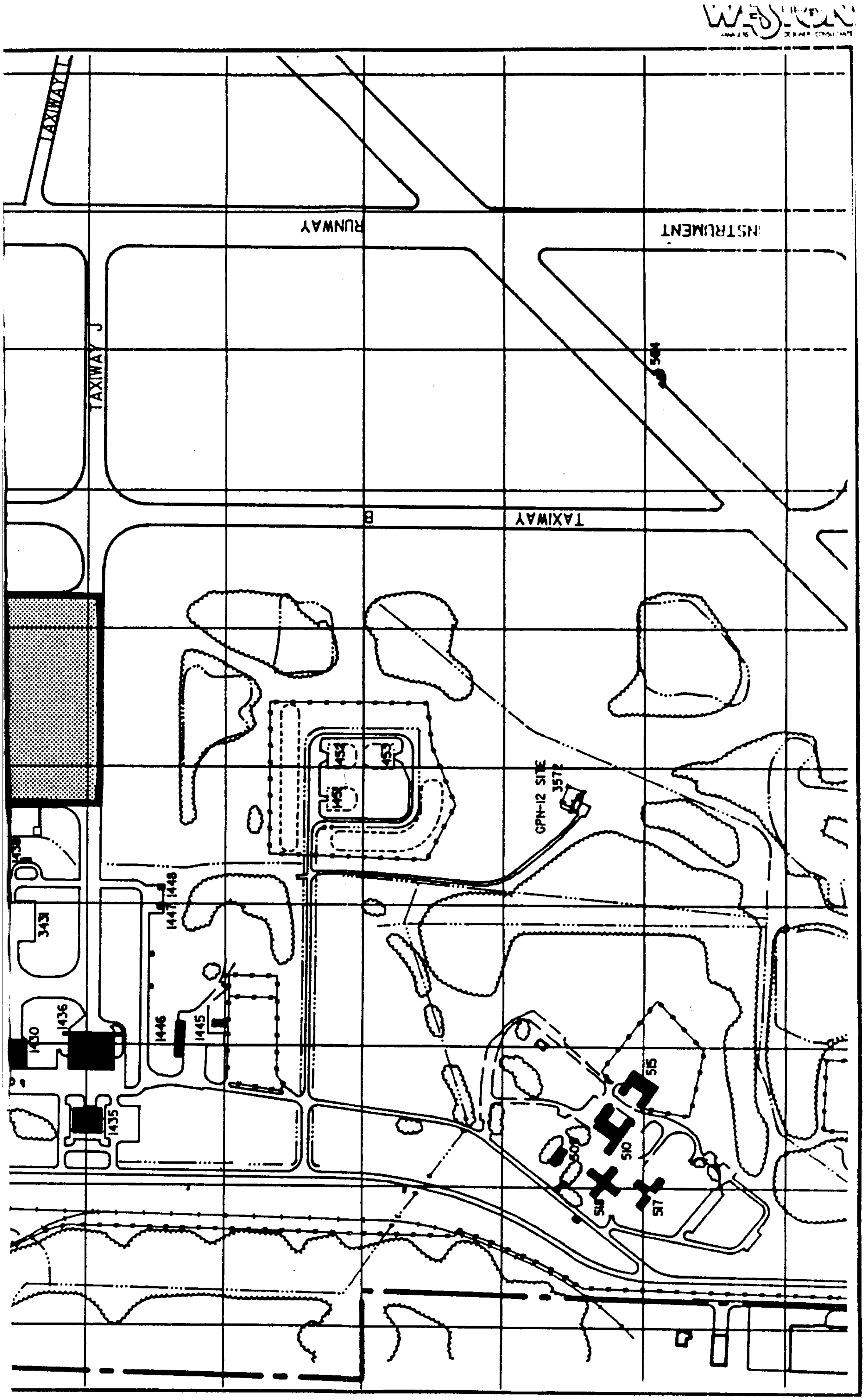


FIGURE 1-8 WEST RAMP (WRMP)
SITE MAP, SELFRIDGE ANGB

dated formation. The wells were sampled and were analyzed for VOCs, TOC, and TPH. Three soil samples were retained from each well installation during drilling and were analyzed for VOCs and O&G. The samples were retained from the 2.5-, 7.5-, and 10.5-foot depths. The results of those analyses are summarized in the following matrix.

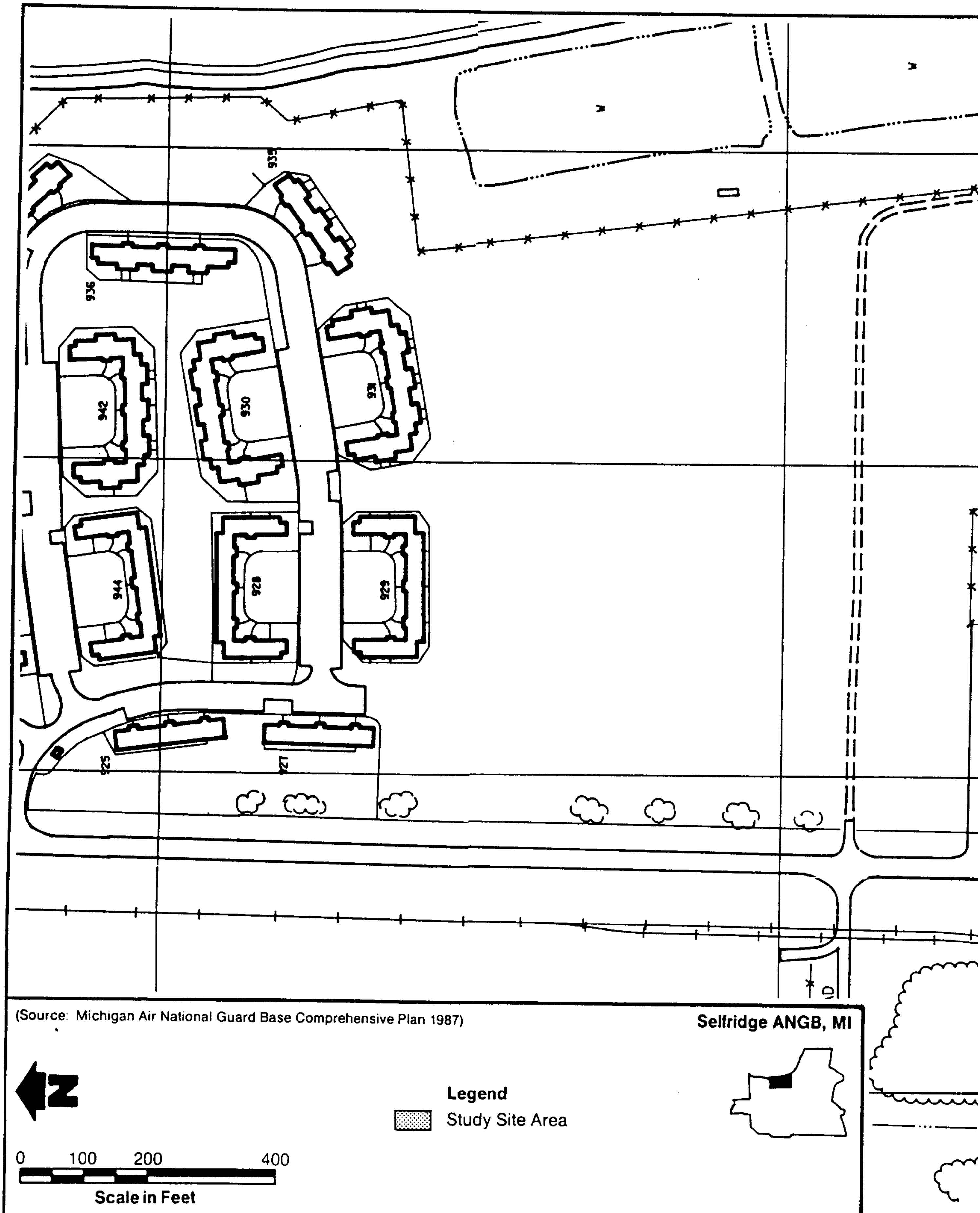
Medium Sampled	Parameter Detected	Range of Concentration
Groundwater	Trichloroethene	<2.0 - 2.5 ug/L
	TOC	8.2 - 12.0 mg/L
	TPH	1.0 - 2.4 mg/L
	pH (units)	6.8 - 7.4
	Specific conductance	777 - 1,350 micro-mho/cm
Soil	Benzene	<4.0 - 24 ug/g
	Chloroethane	<2.0 - 31 ug/g
	Chloroform	<2.0 - 13 ug/g
	Ethylbenzene	<2.0 - 5.2 ug/g
	Methylene chloride	<3.0 - 98 ug/g
	Toluene	<2.0 - 104,000 ug/g
	1,1,1-Trichloroethane	<2.0 - 11 ug/g
	Trichloroethene	60 - 1,500 ug/g
	Trichlorofluoromethane	<3.0 - 100 ug/g
	O&G	65 - 17,900 mg/kg
	EP Toxicity - barium	120 - 1,250 ug/L
	EP Toxicity - selenium	<10 - 11 ug/L
	Ignitability	Not Ignitable

The Phase II Stage 1 drilling found lacustrine silts and clays and a bed of fine sand at approximately 20 to 25 feet BLS. Water saturated materials were encountered within the lacustrine silts and clays at a depth of 6 to 14 feet BLS. An area of silty fine sand encountered at a depth of 20 feet BLS provides the major source of water in the monitor wells. The depth to static water level varied from 0.5 to 3.0 feet BLS. The lateral hydraulic gradient was interpreted to be very flat (approximately 0.0008 feet per foot) and oriented to the south-southwest in the WRMP area.

1.4.5 Site 5: Tucker Creek Landfill (TCLF)

Site Description:

A natural depression on the eastern side of Selfridge ANGB was used for disposing waste materials. The site is bounded on the north by Building 970, on the south by the base school, on the east by Lake St. Clair, and on the west by Jefferson Avenue (see Figure 1-9). The Phase II Stage 1 investigation found some



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(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
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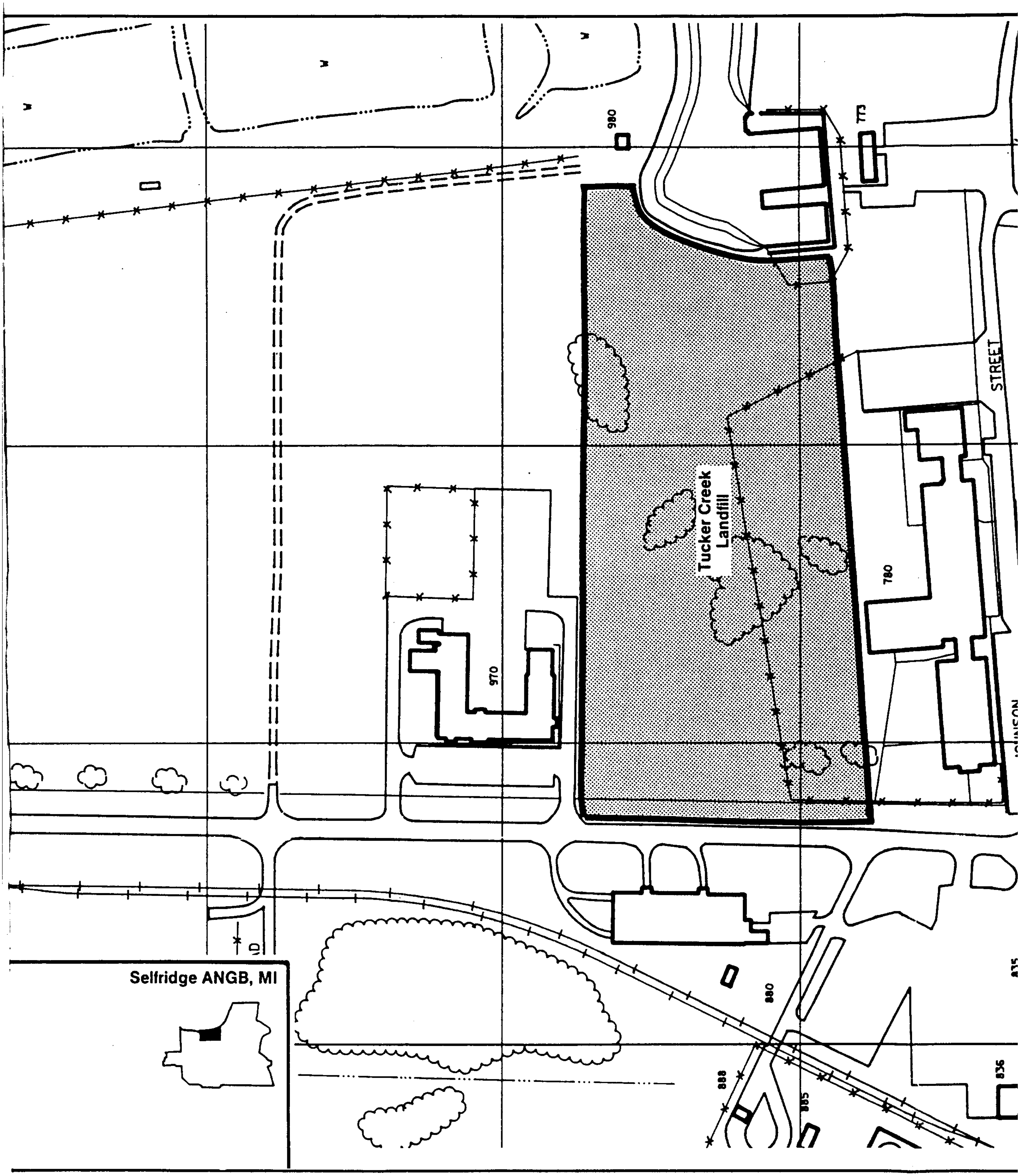
Tucker Creek
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Selfridge ANGB, MI

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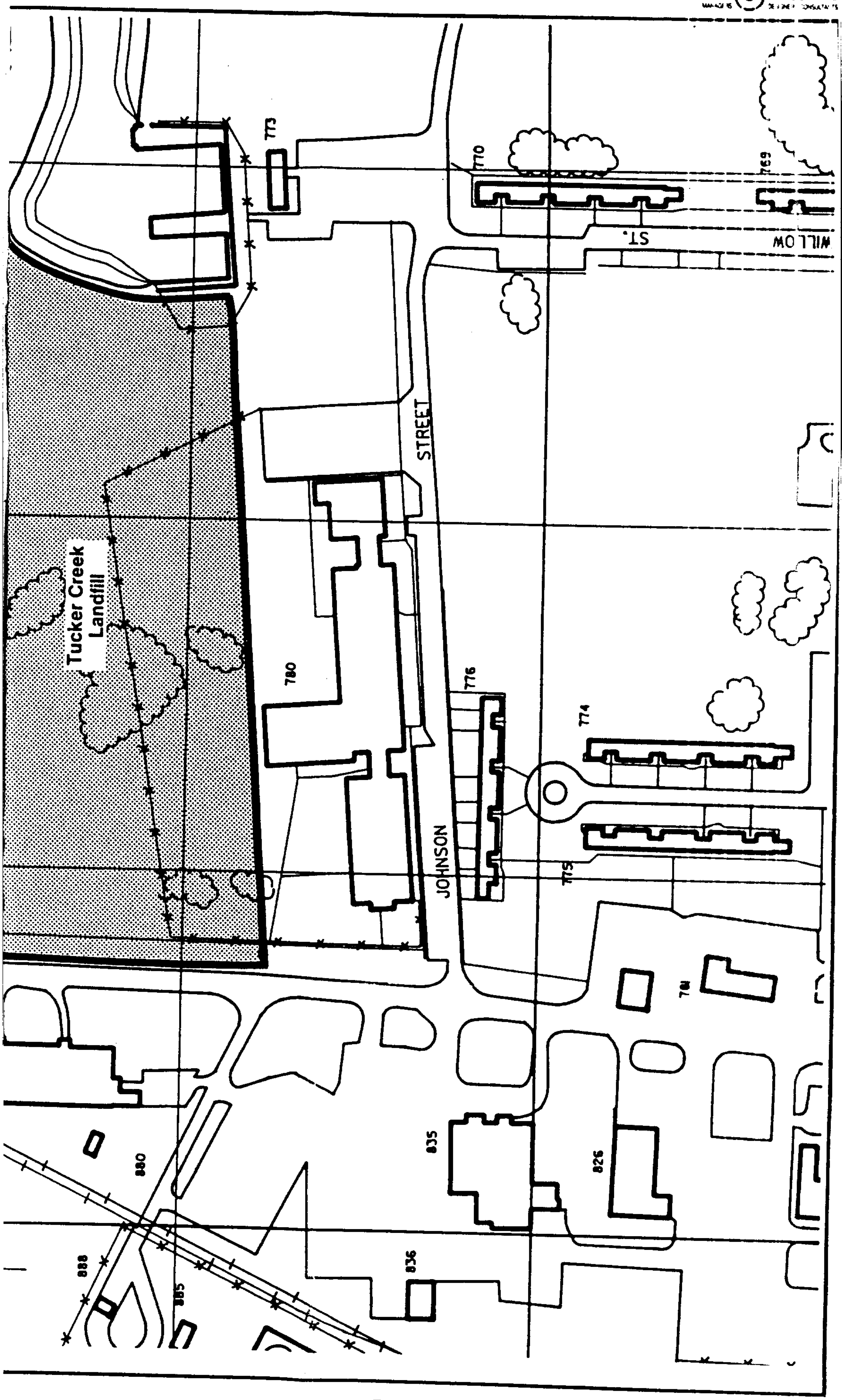


FIGURE 1-9 TUCKER CREEK LANDFILL (TCLF) SITE MAP, SELFRIDGE ANGB

indications that landfill activities may have extended north beyond those boundaries.

Size: 9 acres, minimum

Period of Use: 1930 to 1955

Past Practices:

During its active period, TCLF was used for disposing demolition materials, residential refuse, and industrial waste materials such as carbon tetrachloride and trichloroethene. Refuse was commonly burned in TCLF during that period.

Summary of Phase II Stage 1 Investigation:

During the Phase II Stage 1 investigation, three monitor wells were installed in the unconsolidated formation. Groundwater samples from the wells were analyzed for VOCs, TOC, phenols, COD, heavy metals, and O&G. The results of those analyses are summarized in the following matrix.

Medium Sampled	Parameter Detected	Range of Concentration	
Groundwater	Trichloroethene	2.2 - 3.1	ug/L
	TOC	8.0 - 16.4	mg/L
	Phenolics	<5.0 - 10	ug/L
	COD	194.0 - 688.0	mg/L
	Cadmium	<10.0 - 14	ug/L
	Copper	14 - 1,900	ug/L
	Lead	<10.0 - 44	ug/L
	O&G	0.44 - 1.17	mg/L
	pH (units)	6.9 - 7.0	
	Specific conductance	2,590 - 3,700	micro-mho/cm

Lacustrine clays of high plasticity were found in the well borings. Groundwater was found in the lacustrine silts and clays at a depth of 12 to 14 feet BLS. The static water level occurs within 1 to 4 feet BLS.

The hydraulic gradient was interpreted to be eastward at approximately 0.0044 feet per foot across the site. The relative steepness of the gradient near TCLF suggests either the presence of a source of recharge west of the landfill and/or a belt of material with low permeability near the shoreline of Lake St. Clair.

Summary of Other Investigations:

During the environmental assessment by the Army Corps of Engineers, six monitor wells were installed into the unconsolidated

sediments beneath TCLF. The wells were sampled and analyzed for VOCs, TPH, BNAs, pesticides/PCBs, metals, cyanide, and sulfide. Copper was detected at a maximum concentration of 120 ug/L, arsenic at 50 ug/L, chromium at 40 ug/L, and lead at 80 ug/L.

Sixteen soil samples were collected at the surface, at 2, 5, and 10 feet from ten soil borings. They were analyzed for VOCs, pesticides/PCBs, TPH, and explosives. Methylene chloride was detected at a maximum concentration of 93 ug/kg, trichloroethene at 14 ug/kg, toluene at 7 ug/kg, and tetrachloroethene at 7 ug/kg. The pesticide 4,4'-DDT was detected at a maximum concentration of 23 ug/kg, 4,4'-DDD at 26 ug/kg, and 4,4-DDE' at 46 ug/kg. Phenol was detected at maximum concentration of 93 mg/kg. Maximum concentrations of metals detected include arsenic at 25 mg/kg, copper at 30 mg/kg, chromium at 39 mg/kg, lead at 32 mg/kg, nickel at 44 mg/kg, and zinc at 78 mg/kg.

The environmental assessment found brown clay topsoil, silty black organic material, and brown/gray clay with some mottling in the first 5 feet of the subsurface. The lithology changed to a gray/tan or gray/brown clay with some mottling at 6 to 8 feet BLS, followed by a gray moist clay with high plasticity at 10 to 11 feet BLS. Stiff gray clay with medium plasticity was penetrated at 18 to 21 feet BLS. Groundwater was found in the gray clays at depths of 4 to 16 feet BLS. The water elevations did not indicate a clear pattern of flow in the area monitored for the environmental assessment.

1.4.6 Site 6: Northwest Landfill (NWLF)

NWLF is located in the northwestern corner of the base. Originally, the site was a natural sand pit that was excavated for use in runway construction. It was then used for waste disposal. The site is bounded by Perimeter Road to the north, the airfield to the east, WRMP to the south, and the radar station to the west (see Figure 1-10).

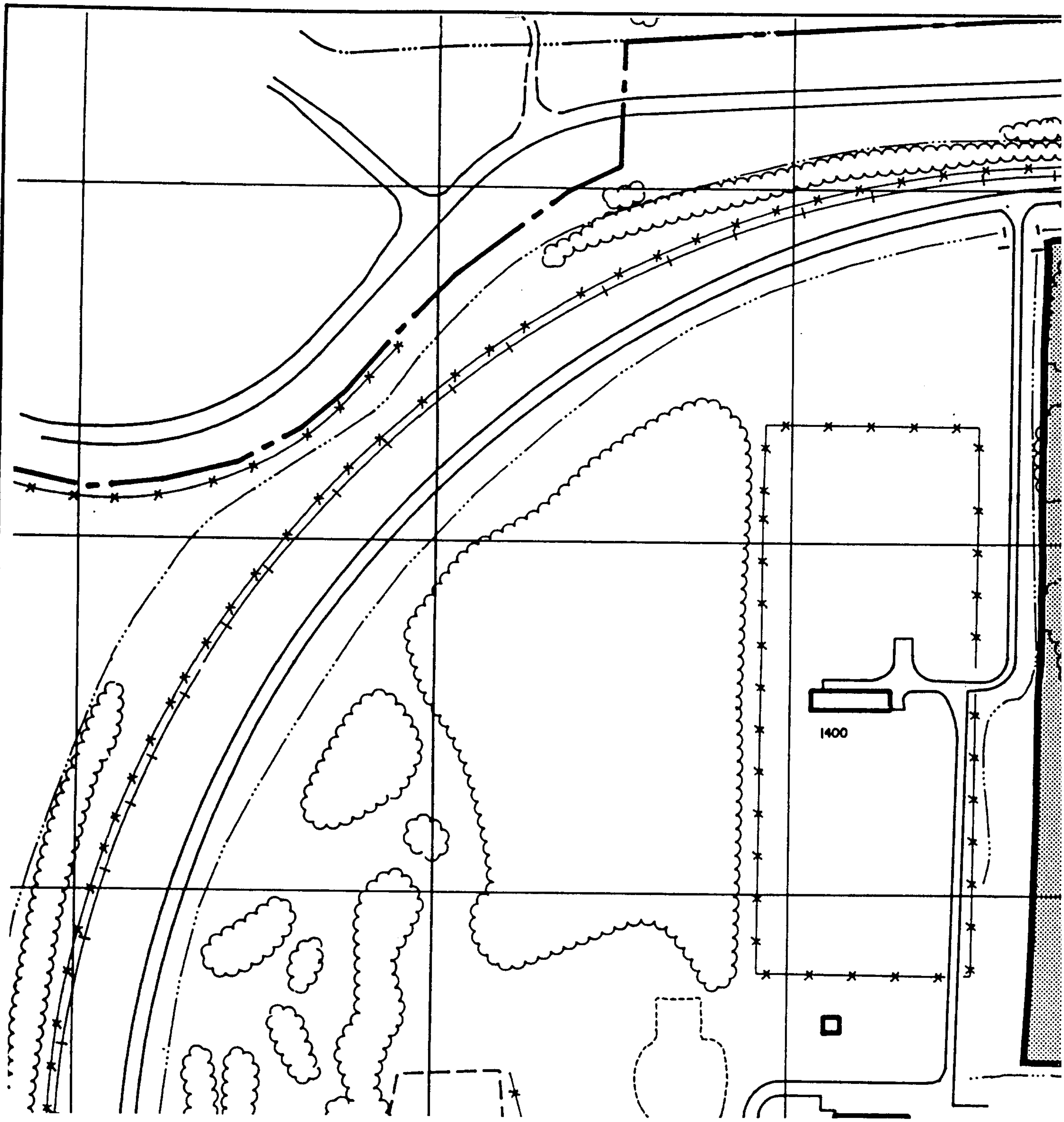
Size: 26 acres — Period of Use: 1955 to 1975

Past Practices:

Demolition materials were placed on the bottom of the pit, followed by residential and industrial waste. Clay and clayey sands were used for daily cover. Industrial waste products, such as solvents, paint thinners, paint strippers, waste oils, and fuels, were landfilled at the site. Base Fuel Management personnel reported that 50 to 150 gallons of tetraethyl lead were disposed at this site during its operation (ENCOTEC, 1983).

Summary of Phase II Stage 1 Investigation:

During the Phase II Stage 1 investigation, three groundwater monitor wells were installed into the unconsolidated formation. The wells were sampled and were analyzed for VOCs, TOC, phenols,



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

Legend

Study Site Area

0 100 200 400

Scale in Feet

04

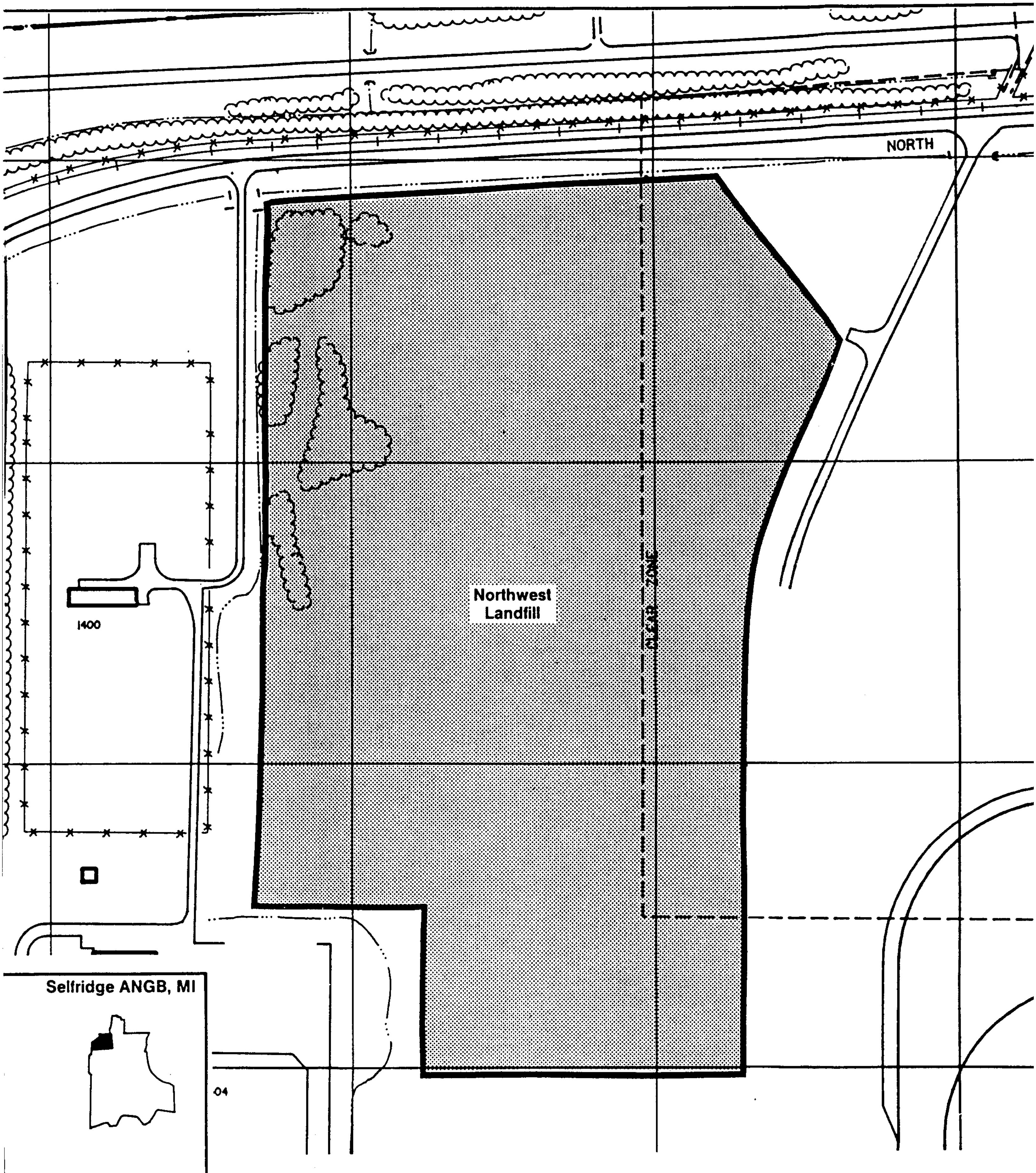


FIGURE 1-10 NO SIT

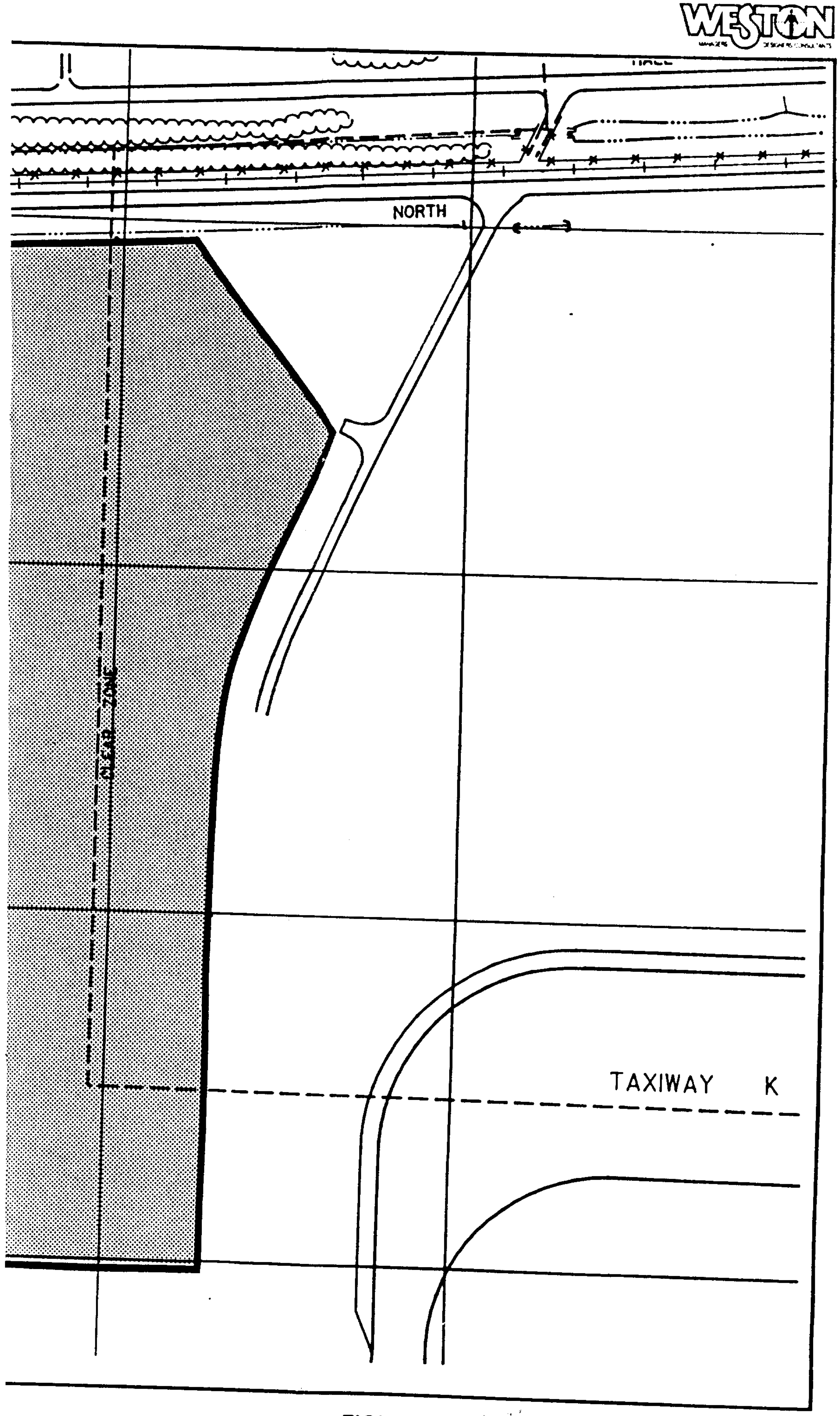


FIGURE 1-10 NORTHWEST LANDFILL (NWLF) SITE MAP, SELFRIDGE ANGB

COD, heavy metals, and O&G. The results of those analyses are summarized in the following matrix.

Medium Sampled	Parameter Detected	Range of Concentration			
Groundwater	Trichloroethene	<2.0	-	2.2	ug/L
	TOC	12.2	-	52.0	mg/L
	Phenolics	<5.0	-	15	ug/L
	COD	63.0	-	565	mg/L
	Copper	<10.0	-	1,600	ug/L
	Lead	<10.0	-	24	ug/L
	O&G	0.32	-	3.7	mg/L
	pH (units)	6.8	-	7.5	
	Specific conductance	404	-	1,450	micro-mho/cm

The Phase II Stage 1 investigation detected a water table (unconfined) aquifer at depths of 2 to 5 feet in surficial sands. Those sands are associated with the historic shoreline of Lake St. Clair that paralleled Sugar Bush Road. South of NWLF, the sands were removed and were used as fill material. The thickness of the water table aquifer probably averages 3 to 5 feet. The aquifer, which is situated above lacustrine silts and clays, is absent in the western portion of NWLF. Saturated conditions within the lacustrine silts and clays occur at a depth of 12 to 14 feet BLS. It is suspected that the groundwater, in both the near-surface sands and the shallow lacustrine deposits, flows northward and discharges to the Tucker-Jones Ditch that bounds the northern perimeter of the base.

1.4.7 Site 7: East Ramp (ERMP)

Site Description:

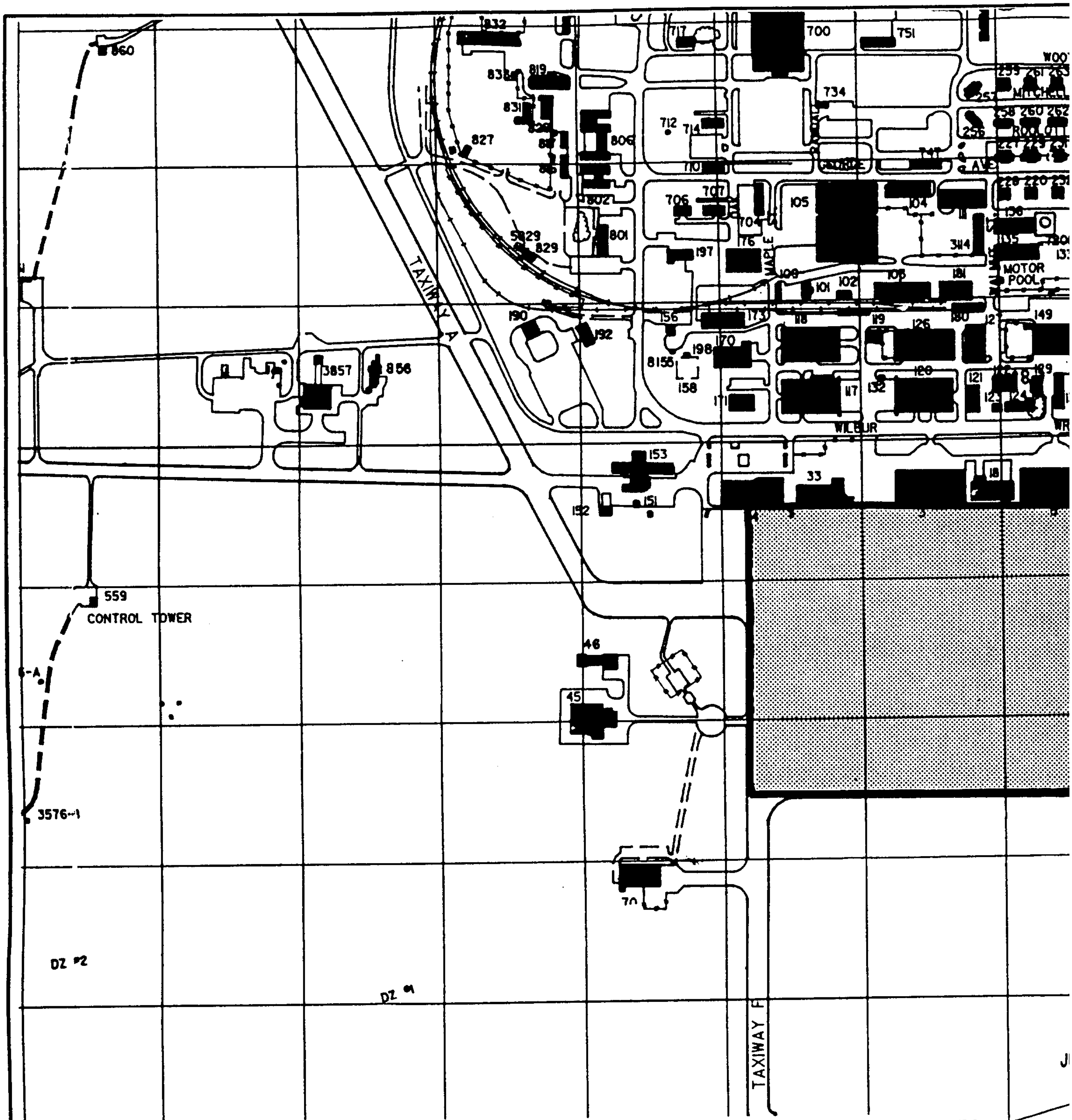
ERMP is located in the southeastern portion of the base. It is bounded on the north and east by Wilbur Wright Avenue, to the south by the golf course, and to the west by the airfield (see Figure 1-11). The ramp is utilized for aircraft parking, maintenance, and fueling.

Size: 75 acres

Period of Use: 1922 to present

Past Practices:

ERMP is used for aircraft parking, maintenance, and fueling. According to the Phase I Report, approximately 6,000 gallons of JP-4 was spilled at an unspecified location on ERMP. Remedial cleanup activities were performed, but the bulk of the spill drained off ERMP. Base personnel have noticed a strong petroleum odor near ERMP during extensive wet periods (ENCOTEC, 1983).



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

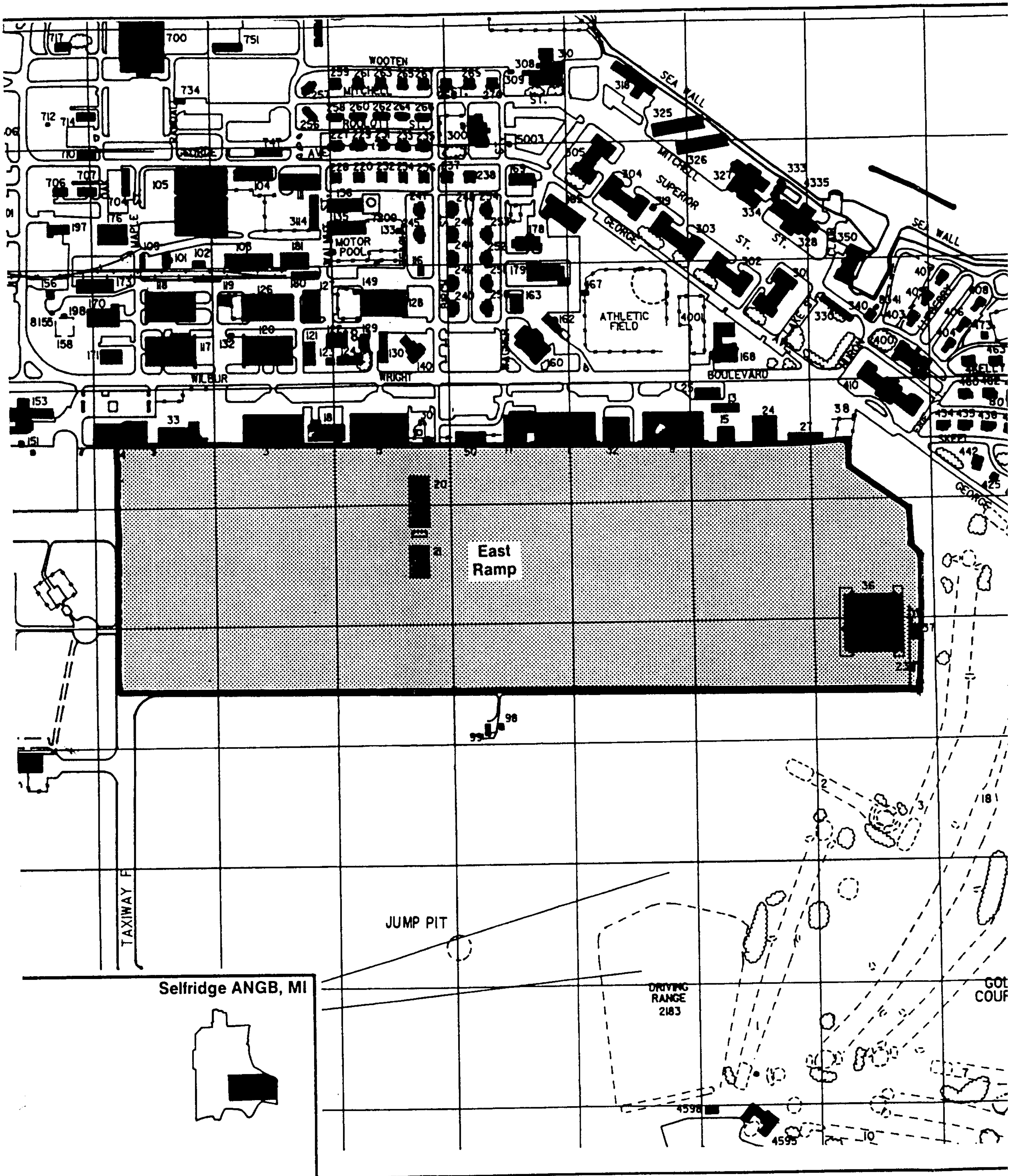
N

Legend

Study Site Area

0 250 500 1000

Scale in Feet



East Ramp
Selfridge ANGB, MI
JUMP PIT
DRIVING RANGE 2183
ATHLETIC FIELD
MOTOR POOL
SEA WALL
WOOTEN
MITCHELL
ST.
GEORGE
AVE
SUPERIOR
WILBUR
WRIGHT
BOULEVARD
MAPLE
TAXIWAY F

FI

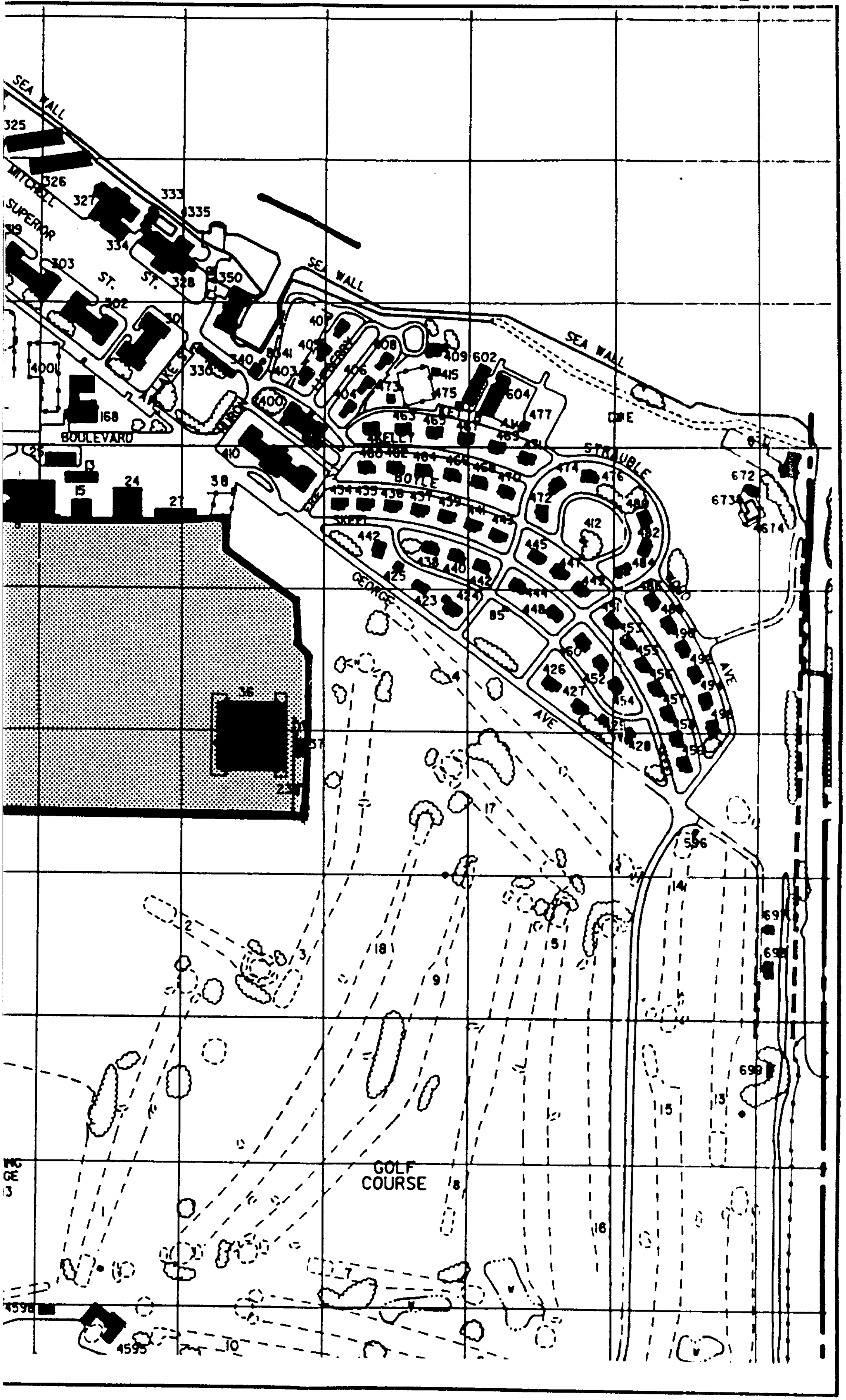


FIGURE 1-11 EAST RAMP (ERMP) SITE MAP, SELFRIDGE ANGB

Summary of Phase II Stage 1 Investigation:

During the Phase II Stage 1 investigation, four groundwater monitor wells were installed into the unconsolidated formation. The wells were sampled and were analyzed for VOCs, TOC, and TPH. Twelve soil samples were collected during drilling (three from each well) and were analyzed for VOCs and O&G. The results of those analyses are summarized in the following matrix.

Medium Sampled	Parameter Detected	Range of Concentration	
Groundwater	Trichloroethene	<2.0 - 9.0	ug/L
	TOC	3.1 - 9.8	mg/L
	TPH	0.6 - 9.2	mg/L
	pH (units)	7.0 - 7.4	
	Specific conductance	534 - 1,140	micro-mho/cm
Soil	Chloroform	<2.0 - 490	ug/g
	Methylene chloride	<3.0 - 1,800	ug/g
	Toluene	<2.0 - 60	ug/g
	1,1,1-Trichloroethane	<2.0 - 2,100	ug/g
	1,1,2-Trichloroethane	<2.0 - 1,000	ug/g
	Trichloroethene	107 - 6,800	ug/g
	Trichlorofluoromethane	<3.0 - 28	ug/g
	O&G	69 - 229	mg/kg

Groundwater was found to occur within the lacustrine silts and clays at a depth of 12 to 14 feet BLS beneath ERMP. The static water levels varied between 1.5 and 5.0 feet BLS. The lateral hydraulic gradient was interpreted to be to the northeast at approximately 0.001 feet per foot.

1.4.8 Site 8: Base Coal Storage Pile (BCSP)

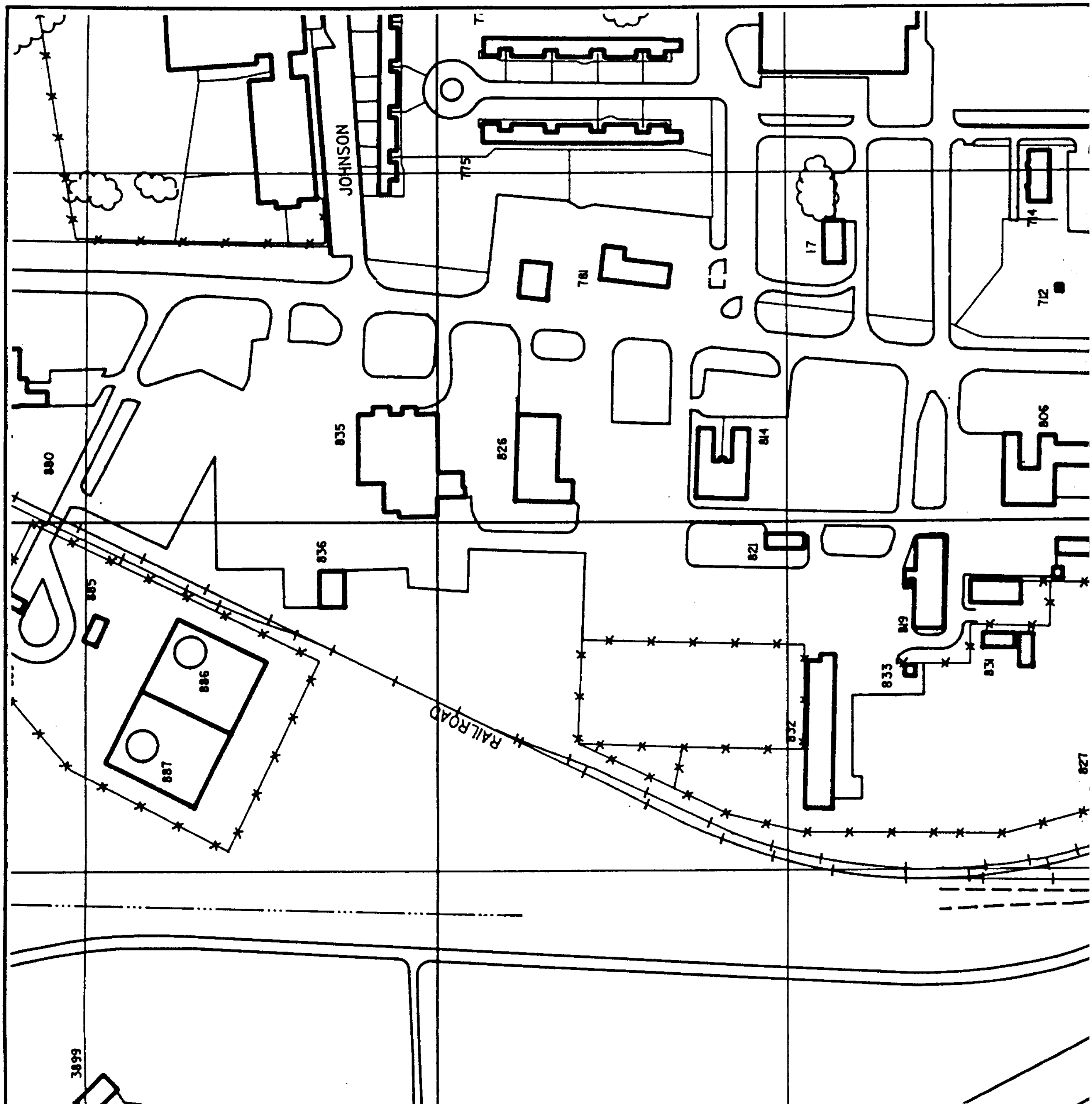
Site Description:

BCSP is located on the eastern portion of the base, adjacent to the Civil Engineering Complex, and northwest of ERMP (see Figure 1-12). It is used to store coal for the base coal-fired power plant.

Size: 5 acres | Period of Use: 1922 to present

Past Practices:

BCSP has been used for storing bituminous coal for use by the base coal-fired power plant.



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

Legend

Study Site Area

0 100 200 400

Scale in Feet

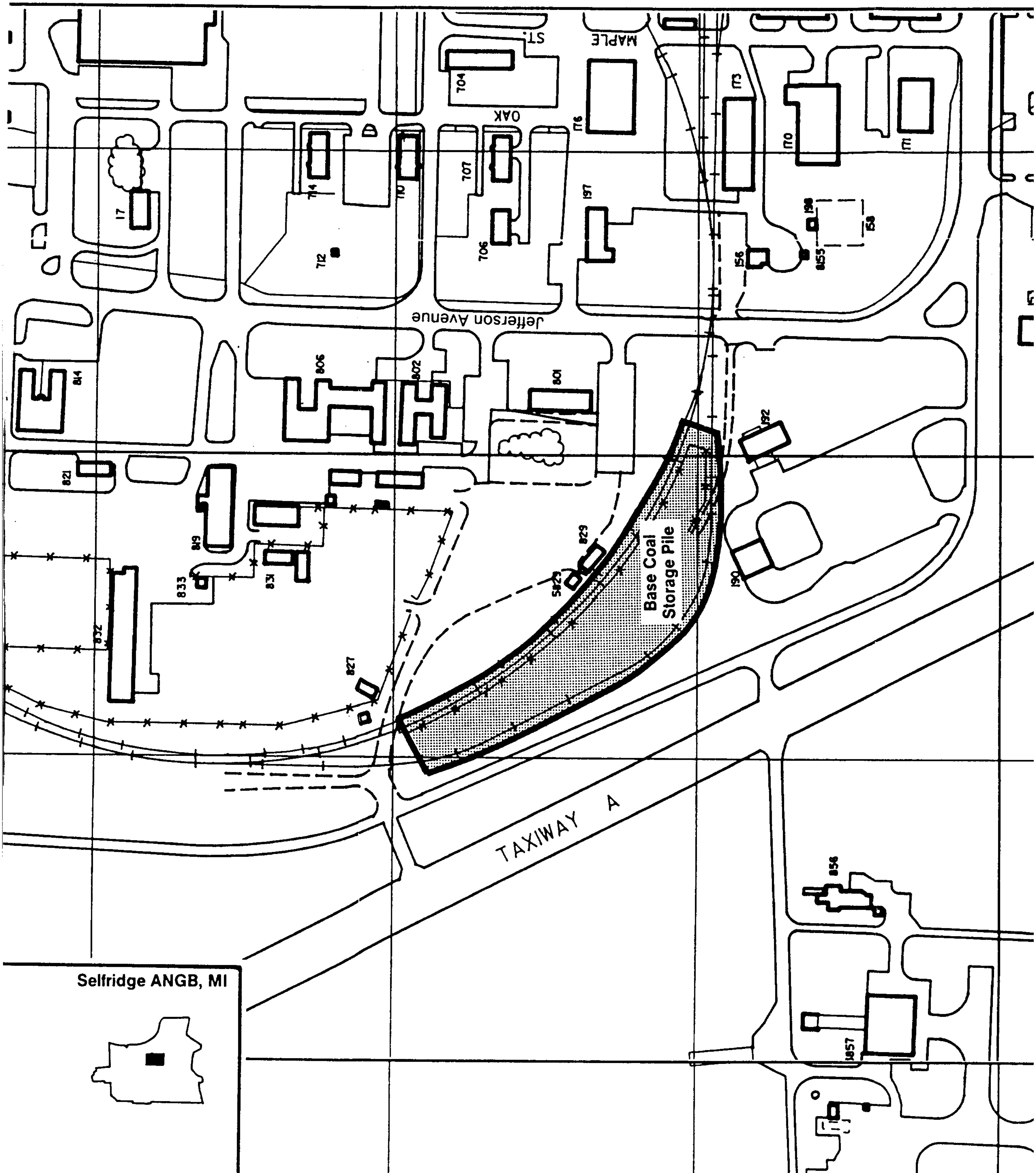


FIGURE 1-12 B
S

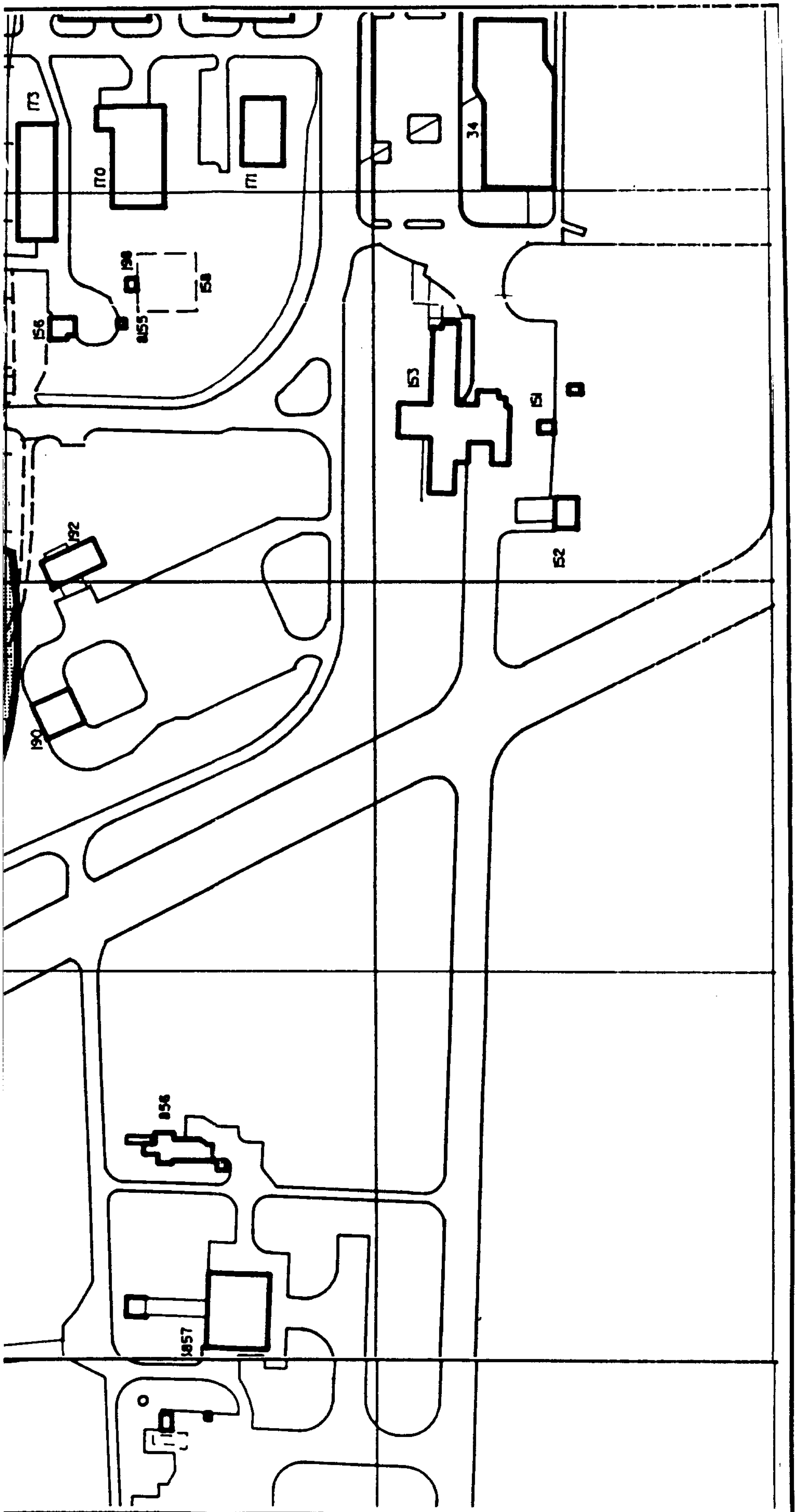


FIGURE 1-12 BASE COAL STORAGE PILE (BCSP) SITE MAP, SELFRIDGE ANGB

Summary of Phase II Stage 1 Investigation:

BCSP was not investigated during the Phase I nor the Phase II Stage 1 investigations. It was added to the list of sites for Stage 2 investigation at the request of base staff.

1.5 WESTON PROJECT PERSONNEL

The IRP Stage 2 study at Selfridge ANGB was conducted principally by personnel from WESTON's Bannockburn, Illinois office. The following personnel served on the management staff for this project:

Program Management

Mr. Peter J. Marks, Program Manager: Corporate Vice President, M.S. in Environmental Science, 19 years experience in laboratory analysis and applied environmental sciences.

Ms. Katherine Sheedy, P.G., Project Director: Corporate Vice President, M.S. in Geology, over 12 years experience in geologic and hydrogeologic investigations.

Mr. P. Steven Young, P.G., Project Operations Manager: Section Manager, M.A.S. in Water Resources, over 9 years experience in geologic and hydrogeologic investigations.

Laboratory Management

Ms. Judy L. Stone: B.A. in Chemistry, 14 years experience in analytical chemistry, data management, and project coordination.

Task Management

Mr. Edward A. Need, P.G., Task Manager: Senior Hydrogeologist and Section Manager for Geosciences in Bannockburn, M.S. in Geology and Water Resources Management, over 8 years experience in hydrogeology and applied geological sciences.

Mr. Christopher W. Krumm, Field Team Leader: Project Geologist, B.A. in Chemistry and Geology, M.S. in Geology and Mineralogy, over 10 years experience in chemical industry as analytical chemist, 2 years experience in hydrogeologic and applied geologic investigations.

The following personnel served on the technical staff for this project:

Field Investigations and Data Interpretation

Mr. Jon D. Olander: Assistant Project Geologist, M.S. in Geology, over 1 year experience in hydrogeologic and applied geologic investigations as a consulting geologist.

Mr. William L. Niemann: Assistant Project Geologist, B.A. in History, B.S. in Geology, M.S. in Geology, 2 years experience in hydrogeology and applied geologic investigations.

Mr. Gregory S. Kinsall: Assistant Project Geologist, B.S. in Geology, 1 year experience in hydrogeological geophysical investigations.

Data Management

Mr. Timothy Murphy: Programmer, B.S. in Computer Science, 4 years experience in computer modeling and computer applications.

Qualitative Risk Assessment

Ms. Julie L. Wilson, Ph.D.: Senior Project Scientist, B.S. in Biology, M.S. in Health Physics, Ph.D. in Toxicology, 8 years experience in public health evaluation and risk assessment.

Mr. Michael A. Stapleton: Senior Project Scientist, B.S. in Earth and Environmental Sciences, 7 years experience in environmental chemistry and risk assessment.

Mr. Peter Erndwein: Assistant Project Scientist, B.S. in Toxicology, 1 year experience in chemical safety and risk assessment.

Preliminary Feasibility Study

Mr. Robert H. Gilbertsen: Assistant Project Engineer, B.S. in Civil Engineering, M.S. in Environmental Engineering, 2 years experience in hazardous waste management.

Mr. Sailesh Banaji: Assistant Project Engineer, B.E. in Civil Engineering, 3 years experience in environmental engineering and feasibility studies.

Technical Editing

Mr. Raymond H. Alexander: Reports Administrator, designated lead editor, B.S. in Chemistry, 12 years experience in industrial chemical research and development, 6 years experience in technical editing.

Full professional profiles are provided in Appendix D for these personnel and others associated with this study.

All analytical work associated with this Delivery Order was performed by WESTON Analytics at its two laboratories in Lionville, Pennsylvania, and University Park, Illinois.

1.6 SUBCONTRACTORS

Soil borings and monitor well installations were completed by Exploration Technology, Incorporated of Madison, Wisconsin. Surveying of soil borings, monitor wells, storm water runoff stations, continuous water level recording locations, and surface sampling locations was completed by Grant Ward Surveyors of Holly, Michigan.

SECTION 2

ENVIRONMENTAL SETTING

2.1 GEOGRAPHIC SETTING

Selfridge ANGB occupies an area of approximately 3,184 acres in Macomb County, southeastern Michigan. The base is located approximately 0.5 miles east of the City of Mt. Clemens and about 14 miles northeast of the City of Detroit. The base is bounded on the east by Lake St. Clair and on the south by the Clinton River, which flows in an eastward direction and discharges to Lake St. Clair (see Figure 2-1).

2.1.1 Physiography

The State of Michigan lies within the Central Lowland Physiographic Province of the Interior Plains as defined by Fenneman (1938). This province has a landscape that is dominated by the effects of glaciation. Macomb County is located in the Eastern Lake Section of the Central Lowland Province and is characterized by maturely dissected and glaciated cuestas, lowlands, moraines, lakes, and lacustrine plains. Relief within the section varies from moderate in areas of cuestas and moraines to low in areas of lakes and lacustrine plains.

Selfridge ANGB is located on glacial lake bed deposits of ancestral Lake St. Clair. Consistent with its setting adjacent to Lake St. Clair, the base has a land surface with very low relief. The natural topography of Selfridge ANGB results from glacial, lacustrine, and fluvial processes. With the exception of a few small embankments associated with construction, present maximum relief on the base is approximately 10 feet. Elevations range from 585 feet above mean sea level (MSL) at the extreme northwestern corner of the base to 575 feet above MSL at the present shoreline (see Figure 2-1).

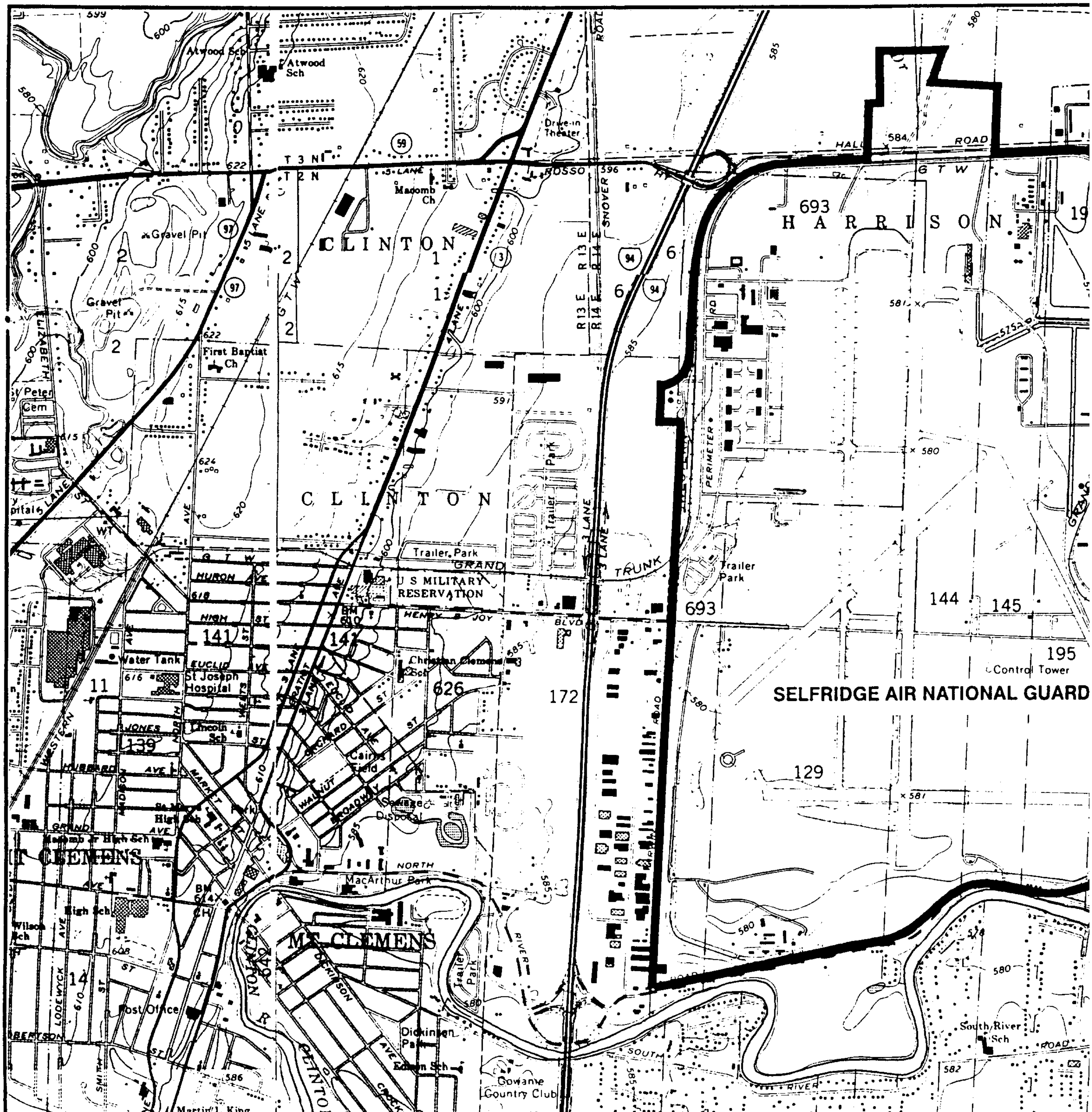
2.1.2 Cultural Geography

2.1.2.1 Land Use and Industry

Macomb County displays a wide range of land uses. The northern areas of the county are mainly rural with small farming communities. The southern portions of the county are predominantly urban and industrial.

Land use adjacent to the base is as follows:

- To the north -- mostly open space with some commercial use along Hall Road near the Base Main Gate and residential use along the lake shoreline.



(Source: U.S. Department of the Interior Geological Survey Topographic Map 1983)

Selfridge ANGB, MI

Legend

Base Boundary

Contour Interval 5 Feet

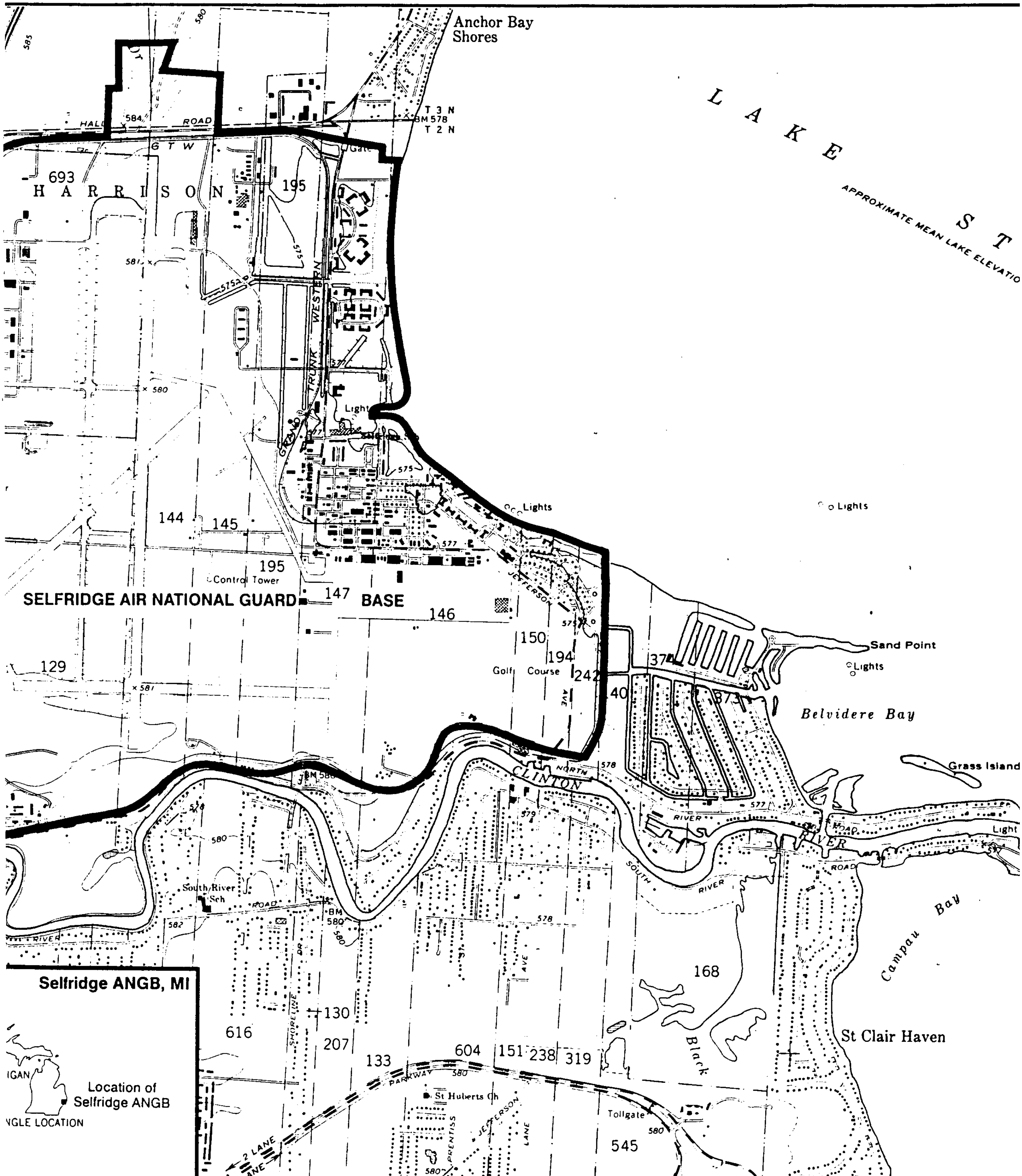
0 1000 2000 3000 4000

Scale in Feet

MICHIGAN

QUADRANGLE LOCATION

Location of Selfridge ANGB


Anchor Bay Shores
LAKE ST
APPROXIMATE MEAN LAKE ELEVATIO
HALL ROAD
T 3 N
BM 578
T 2 N
G T W
Gate
HARRISON
GRAND TRUNK WESTERN
Light
Lights
SELFRIDGE AIR NATIONAL GUARD BASE
Control Tower
Golf Course
JEFFERSON AVE
Sand Point
Belvidere Bay
Grass Island
CLINTON RIVER
NORTH RIVER ROAD
SOUTH RIVER
South River Sch
Campau Bay
St Clair Haven
Black
SHORELINE DR
PARKWAY
St Huberts Ch
PRENTISS
Tollgate
2 LANE
Selfridge ANGB, MI
Location of Selfridge ANGB
693
195
144
145
147
146
150
194
242
129
374
40
373
168
616
130
207
133
604
151
238
319
545
FIGURE 2

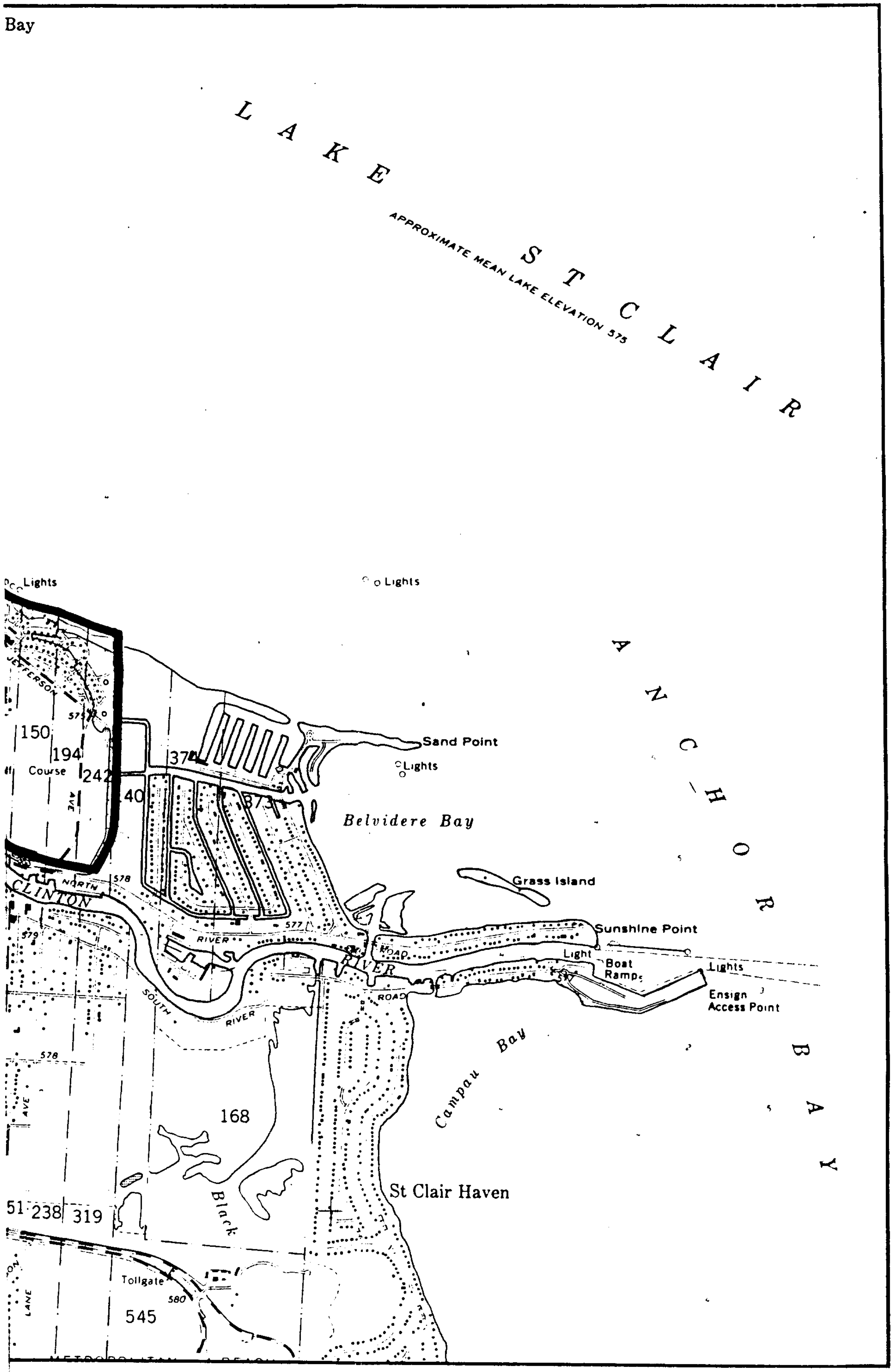


FIGURE 2-1 PHYSIOGRAPHY OF THE SELFRIDGE ANGB AREA

- To the west -- open space and trailer park/residential use north of Joy Boulevard and commercial/light industrial use and open space south of Joy Boulevard.

- To the south -- mostly open space with some residential use between the base and the Clinton River and residential use south of the river.

- To the east -- residential use and Lake St. Clair. Both Lake St. Clair and the Clinton River are used for recreational purposes.

According to the Macomb County Chamber of Commerce, manufacturing industries in Macomb County employ approximately 94,000 people (1981 census), representing over $2.5 billion in annual payroll. The majority of those jobs are in administrative offices and auxiliary industries, which include warehouses, research labs, and maintenance businesses. Industries related to automotive production are also a major employer for the county. A quickly growing area employer in recent years has been the retail industry, most significantly food and drink establishments.

2.1.2.2 Recreational and Cultural Resources

Many of the recreational activities for the residents of Macomb County and the surrounding area revolve around Lake St. Clair. Summer activities include boating, swimming, and fishing, while during the winter months skating, ice boating, ice fishing, and snowmobiling are popular sports. Metropolitan Beach Metropark, located 1.5 miles southwest of Selfridge ANGB, is a popular area for swimming, golfing, and picnicking. There is also an 18-hole golf course in the southeastern portion of Selfridge ANGB.

Macomb County has numerous cultural features for the enjoyment of area residents, including the Macomb Center for the Performing Arts, the Art Center, Michigan Transit Museum, Great Lakes Dinner Playhouse, Crocker House Historical Museum, and Handgem Hunter's Museum and Hall of Fame. Located at Selfridge ANGB is the Selfridge Military Air Museum. The museum contains both indoor and outdoor displays of historical military hardware, art, photos, and memorabilia. The museum is open to public viewing. Each summer the base hosts an open house for the public featuring air shows and a variety of military displays and demonstrations.

2.1.2.3 Population and Demographics

Selfridge ANGB is situated in Harrison Township in central Macomb County. During the 1970s the population in the central Macomb area grew by over 42 percent. By the year 2000 it is estimated that 40 percent of countywide growth will occur in central Macomb County (U.S. Census Bureau).

The current population characteristics for Harrison Township and the City of Mt. Clemens were obtained from the Macomb County Planning Commission and are presented below:

Population	1980	1985 (est.)	% Change
Macomb County	694,600	687,800	-0.01
Mt. Clemens	18,991	18,600	-2.1
Harrison Township	23,464	24,100	2.1

The age distribution of the area, based on the 1980 population census, is as follows:

Age Group	Macomb County	Mt. Clemens	Harrison Township
0-4	46,651	1,408	1,713
5-19	186,983	4,341	5,669
20-34	177,475	5,507	7,379
35-44	85,354	1,730	2,931
45-59	116,260	2,762	3,653
60-64	28,382	833	793
65 and over	53,495	2,225	1,511

The race distribution of the area, based on the 1980 population census, is as follows:

Race	Macomb County	Mt. Clemens	Harrison Township
White	675,135	15,046	22,783
Black	9,142	3,437	467
Other	10,323	323	399

The educational background of the area, based on the 1980 population census, is as follows:

Education	Macomb County	Mt. Clemens	Harrison Township
Elementary			
0-8 years	53,540	1,597	1,338
High School			
1-3 years	68,803	2,280	2,185
1-4 years	167,881	3,911	5,889
College			
1-3 years	63,633	1,876	2,473
4 years	42,723	1,251	1,743

2.1.2.4 Socioeconomics

The effective buying income (or disposable income) of Macomb County households, based on 1985 statistics, was $32,922, compared with $32,286 for the State of Michigan overall. Per capita income and median household income for the area are presented

below. In general, Harrison Township has a slightly higher per capita income that can perhaps be attributed to its close proximity and financial involvement with activities on Lake St. Clair.

	Per Capita Income (1985)	Median Household Income (1985)
Macomb County	$8,655	$24,222
Mt. Clemens	$7,486	$17,109
Harrison Township	$9,428	$22,243

There has been a significant increase in the housing supply in Macomb County and in the City of Mt. Clemens to a lesser degree. The housing characteristics for years 1970 and 1980 are presented below.

Macomb County

	1970	1980	% Change
Total Housing Units	176,320	236,455	34.1
Owner Occupied	142,601	182,464	28.0
Renter Occupied	28,977	47,356	63.4

Mt. Clemens

	1970	1980	% Change
Total Housing Units	6,821	7,359	7.9
Owner Occupied	4,009	4,111	2.5
Renter Occupied	2,579	2,941	14.0

Harrison Township

	1970	1980	% Change
Total Housing Units	5,773	9,292	61.0
Owner Occupied	4,100	5,773	40.8
Renter Occupied	1,419	2,904	104.6

The median price of houses in Macomb County in 1980 was $51,000, while it was $37,800 in the City of Mt. Clemens. There were a number of vacant units available in the county and Mt. Clemens, representing vacancy rates of 2.8 and 4 percent, respectively.

The transportation system near Selfridge ANGB is primarily highways. Interstate 94, running north-south through Harrison Township, and State Highway 59, just north of Mt. Clemens, are the major highways serving the communities in the vicinity of the base. Air transportation, railways, and waterways also provide for the movement of people, goods, and services.

2.2 GEOLOGY

2.2.1 Geologic Setting

2.2.1.1 Structural and Historical Overview

Selfridge ANGB is located on the southeastern edge of a geologic structure known as the Michigan Basin, which includes all of the Lower Peninsula of Michigan, as well as parts of several other states and Canada. The Michigan Basin consists of sedimentary rocks ranging from Cambrian to Jurassic ages. Overlying the rock formations of the basin is unconsolidated glacial drift that was deposited during the Pleistocene and unconsolidated fluvial and lacustrine deposits that resulted from ongoing surficial processes during the Holocene.

2.2.1.2 Geomorphology

The near-surface geology at Selfridge ANGB is glacial in nature, but has also been influenced by lacustrine and fluvial processes. Excavation and fill operations have also had an effect on most areas of the base.

Selfridge ANGB is situated on the northwestern shore of Lake St. Clair. Ancestral Lake St. Clair stood at higher levels due to large volumes of meltwater from Pleistocene glaciers. These higher lake levels are represented by two paleo-shorelines or strandlines. These strandlines are reflected in the present topography as subdued ridges. The younger of the two strandlines is defined by the former route of Sugarbush Road along the western edge of the base. The route of Gratiot Avenue, located west of the base, follows the older strandline (see Figure 2-1).

Relief on base is due to a combination of natural and manmade surface features. A strandline on the western side of the base forms a natural topographic high. From this high point, the ground surface at the base generally slopes eastward toward the lake at a very gentle gradient. The ground surface is also somewhat higher along the southern edge of the base where the Clinton River is present. A large percentage of the base has been reclaimed from the low-lying areas bounding the lake. The reclaimed area was comprised of lake-margin marsh lands developed on the former lake bed. The natural topography has been modified by excavation and fill operations during the construction of buildings, runways, taxiways, roads, and landfills.

Drainage from the base occurs via natural and man-made drainage networks to either the Clinton River or Lake St. Clair. An elaborate system of storm drains, ditches, and lift stations collects surface water runoff and conveys it off the base. Along the northern perimeter, a man-made ditch drains water into Lake St. Clair. These features are discussed in more detail in Subsection 2.3.2.

2.2.2 Bedrock Geology

2.2.2.1 Stratigraphy

The unconsolidated overburden at Selfridge ANGB is underlain by the Antrim Shale of late Devonian Age (see Figure 2-2). This formation ranges in thickness from 120 feet, where it is cut by Pleistocene erosion, to 600 feet in portions of northern Michigan. The Antrim Shale is a dark gray to black and brown, hard, thin-bedded, brittle, carbonaceous shale. Well logs available for the area just south of the base have reported bedrock at depths of approximately 95 to 105 feet BLS.

The Antrim Shale overlies the Traverse Group, which is of middle to late Devonian Age. The Traverse Group is divided into three units. These units, in descending order, are the Traverse Formation, Traverse Limestone, and Bell Shale. The Traverse Group as a whole ranges in thickness from approximately 100 to 800 feet (Geological Survey Division, Michigan Department of Natural Resources, 1977).

2.2.2.2 Structural Geology

Selfridge ANGB is located on the southeastern flank of the Michigan Basin, a broad structural basin consisting of downwarped sedimentary rock. The rock sequence ranges from older Cambrian rocks around the edges to younger Jurassic rocks in the middle of the basin. Beneath the Cambrian rocks are strata of Precambrian Age. These include igneous, metamorphic, and sedimentary rocks.

The Michigan Basin is believed to have originated in Precambrian time, with a continuation of downwarping throughout Paleozoic time. On the basis of previous studies, major periods of downwarping appear to have occurred during Silurian and Devonian times. Because of the thickness of unconsolidated sediments at the base, the bedrock structure is significant only as a possible indication of upward groundwater gradient and flow.

2.2.3 Surficial Geology

Selfridge ANGB is underlain by unconsolidated materials of three depositional environments: lacustrine, glacial, and fluvial. Most of the base is located on clayey lacustrine deposits of ancestral Lake St. Clair. The lacustrine sediments are comprised of clay and silt with occasional lenses of silt or sand. Some of these coarser sediments are shoreline deposits of ancestral Lake St. Clair. The southeastern section of the base lies on a peninsula that separates Anchor Bay from L'anse Creuse Bay to the south. The Clinton River meanders along the axis of the peninsula, suggesting a fluvial origin for the peninsula, possibly a delta formed in ancestral Lake St. Clair. The discontinuous deposits of sand found in the

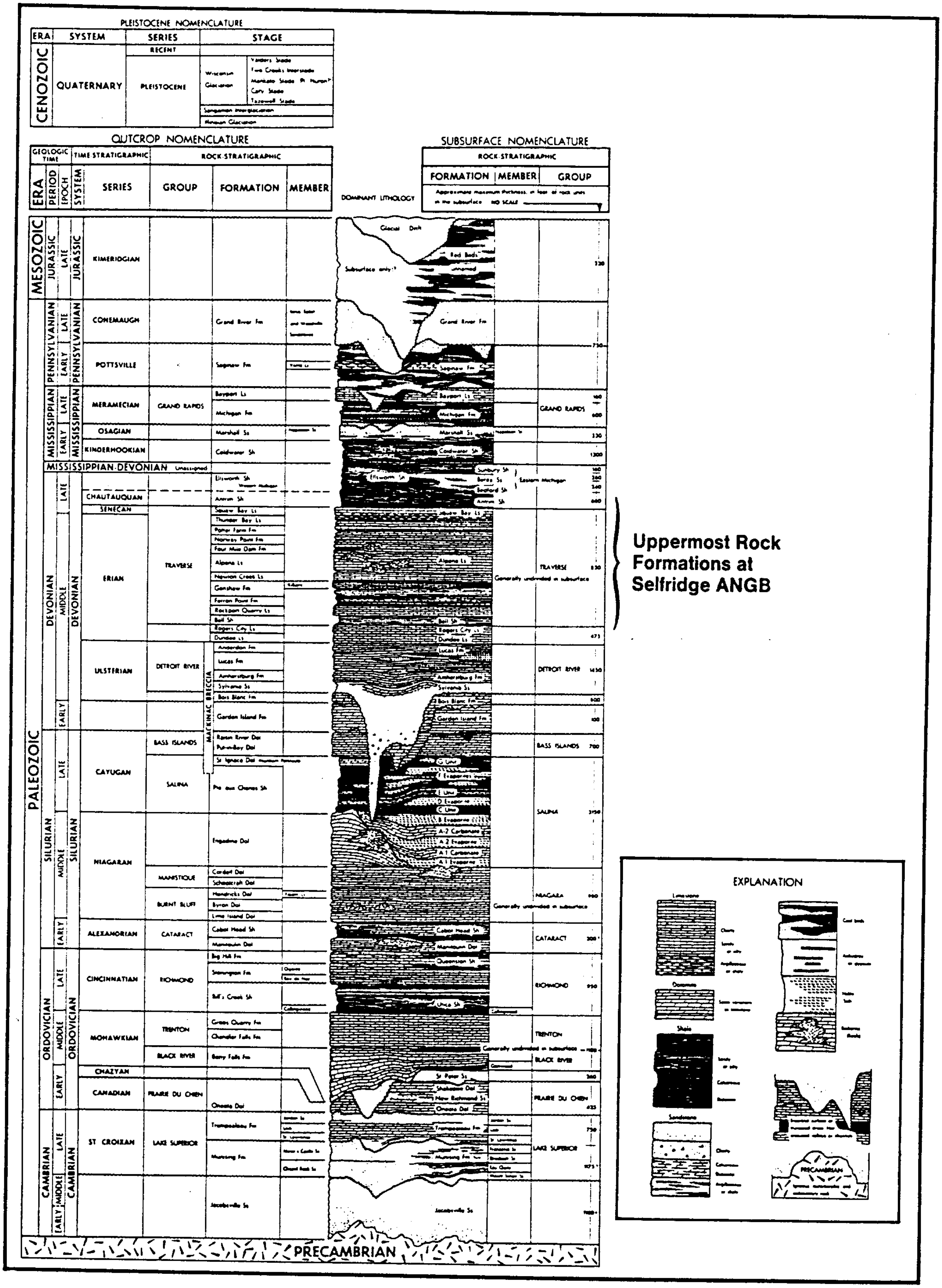


FIGURE 2-2 STRATIGRAPHIC COLUMN FOR THE STATE OF MICHIGAN

2.2.4 Soils

Soil formation is caused by weathering and other processes that act on material deposited by geologic agents. The parent materials of the soil are predominantly glacially related sediment in the vicinity of Selfridge ANGB.

Soil associations are ways of generalizing similar types of soils over a broad area. An association is described as a landscape that has a distinctive proportional pattern of soils. An association normally consists of one or more major soils and at least one minor soil.

Soils that have similar profiles (sequences of natural layers) make up a soil series. Except for a difference in surface texture, all the soils of a series have major horizons that are similar in thickness, arrangement, and other important characteristics.

2.2.4.1 Soils at Selfridge ANGB

The majority of Selfridge ANGB has been disturbed by grading, cutting, and filling, and as a result, the dominant soil type mapped by the USDA/SCS is Made land.

Most of the naturally occurring soils at the base are of the Toledo-Paulding association as shown in Figure 2-3. This association consists of nearly level, poorly drained soils that formed in lake-deposited clay. Part of the southern half of the base is located on soils of the Lenawee-Corunna-Lamson association, the presence of which may reflect the influence of the Clinton River on the texture of available parent materials. This association consists of nearly level, poorly drained soils that formed in lake-deposited and possibly fluvial sediments. Soil textures in this association range from clay loams to sandy loams.

The most significant property of the soils at the base affecting potential containment migration is their low permeabilities. Combined with the low relief at the base, low soil permeability results in surficial ponding of precipitation, because both infiltration and runoff are slow. Those conditions necessitated construction of the stormwater sewer system described in Subsection 2.3.2.1. However, that system now provides a very rapid migration pathway for contaminants entering it. Low soil permeabilities, low relief, and topographic position (similarity in elevation to the water level in the lake) combined to produce water tables within 15 feet BLS as described in Subsection 2.3.1.1. This means that shallowly buried wastes may be in contact with groundwater, enhancing leachate generation. However, the low soil permeabilities also mean that groundwater flow velocities are low and that contaminant migration via groundwater is slow.

southwestern corner of the base were interpreted during the IRP Phase II Stage 1 study to have been alluvial deposits of the Clinton River.

2.2.3.1 Findings of Previous Investigations

The Phase II Stage 1 investigations concluded that the unconsolidated overburden in the vicinity of Selfridge ANGB consists of the following units:

- Gray to dark brown, plastic clays of lacustrine origin with minor fine sand and silt. This unit was deposited by low-energy sedimentation in ancestral Lake St. Clair. This is the predominant surficial unit on the base and was estimated to be a maximum of 35 to 50 feet thick.

- Buff to light brown sand and small gravel with minor silt and clay-sized fraction. This unit represents the moderate- to high-energy sedimentary environments along the shoreline of ancestral Lake St. Clair on the western portion of the base. Because of the coarse-grained nature of this unit, it has been used extensively as a source of fill material at the base and is no longer present in its original morphology. It is estimated that the thickness of this unit was less than 15 feet prior to the initiation of regrading activities at the base.

- Gray to brown, moderately to poorly sorted clays, silts, sands, and gravels. This alluvial unit was deposited along the southern portion of the base by the sediment transport mechanisms associated with the Clinton River. A similar belt of alluvial deposits was postulated to occur along the former course of Tucker Creek.

- Moderately to poorly sorted clays, silts, sands, and gravels of glacial origin. This unit outcrops west of the Gratiot Avenue shoreline and occurs at a depth of approximately 20 to 30 feet below land surface in the vicinity of the base. The existing well logs in the Macomb County area suggest that the glacial deposits become coarser with depth.

Soil borings completed during the Army Corps of Engineers Environmental Assessment north of Tucker Creek penetrated the lacustrine and glacial till units. Well logs from the area just south of the base indicate the thickness of the lacustrine and glacial till deposits to be approximately 95 to 105 feet.

2.2.4 Soils

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Soil associations are ways of generalizing similar types of soils over a broad area. An association is described as a landscape that has a distinctive proportional pattern of soils. An association normally consists of one or more major soils and at least one minor soil.

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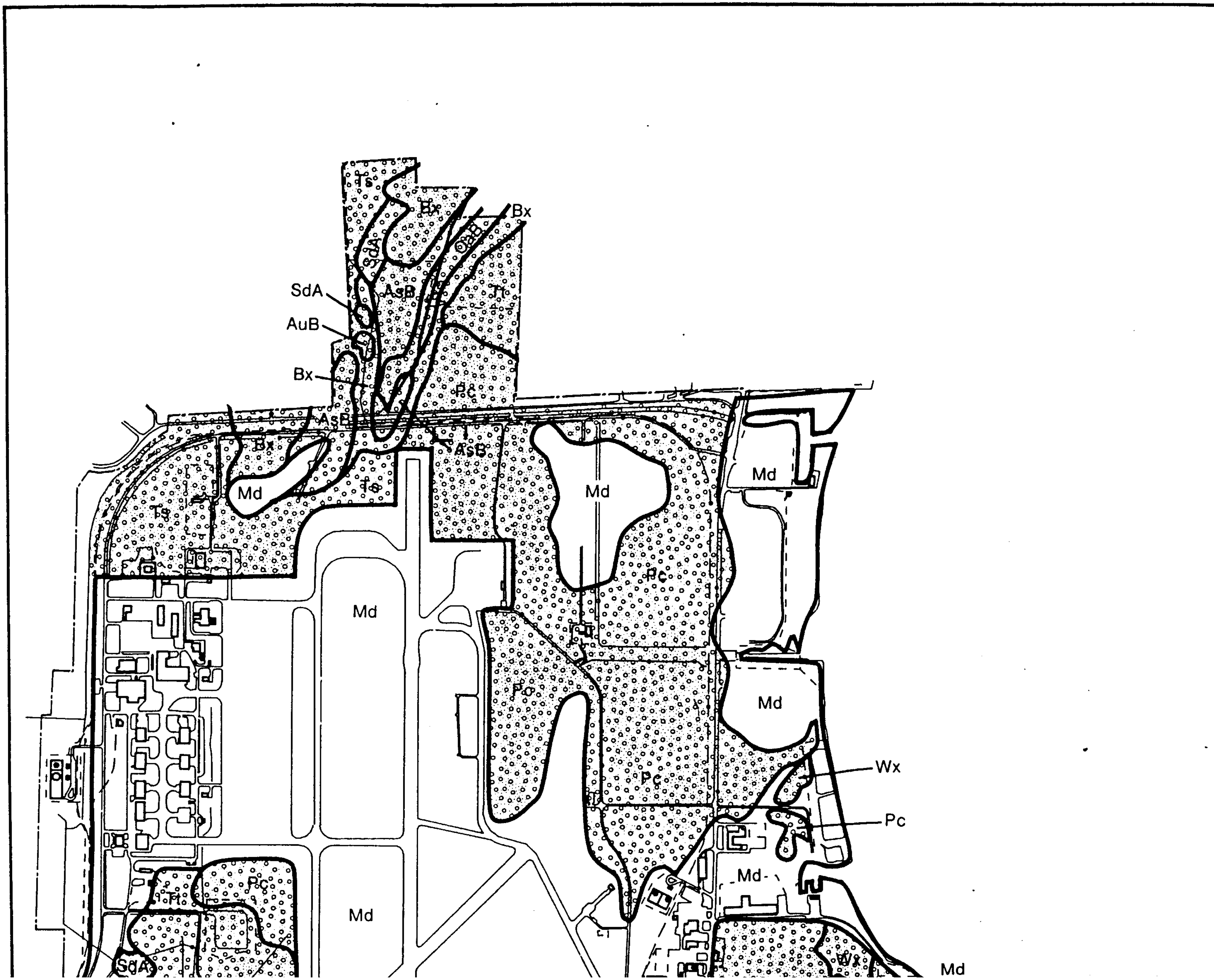

Ts
Bx
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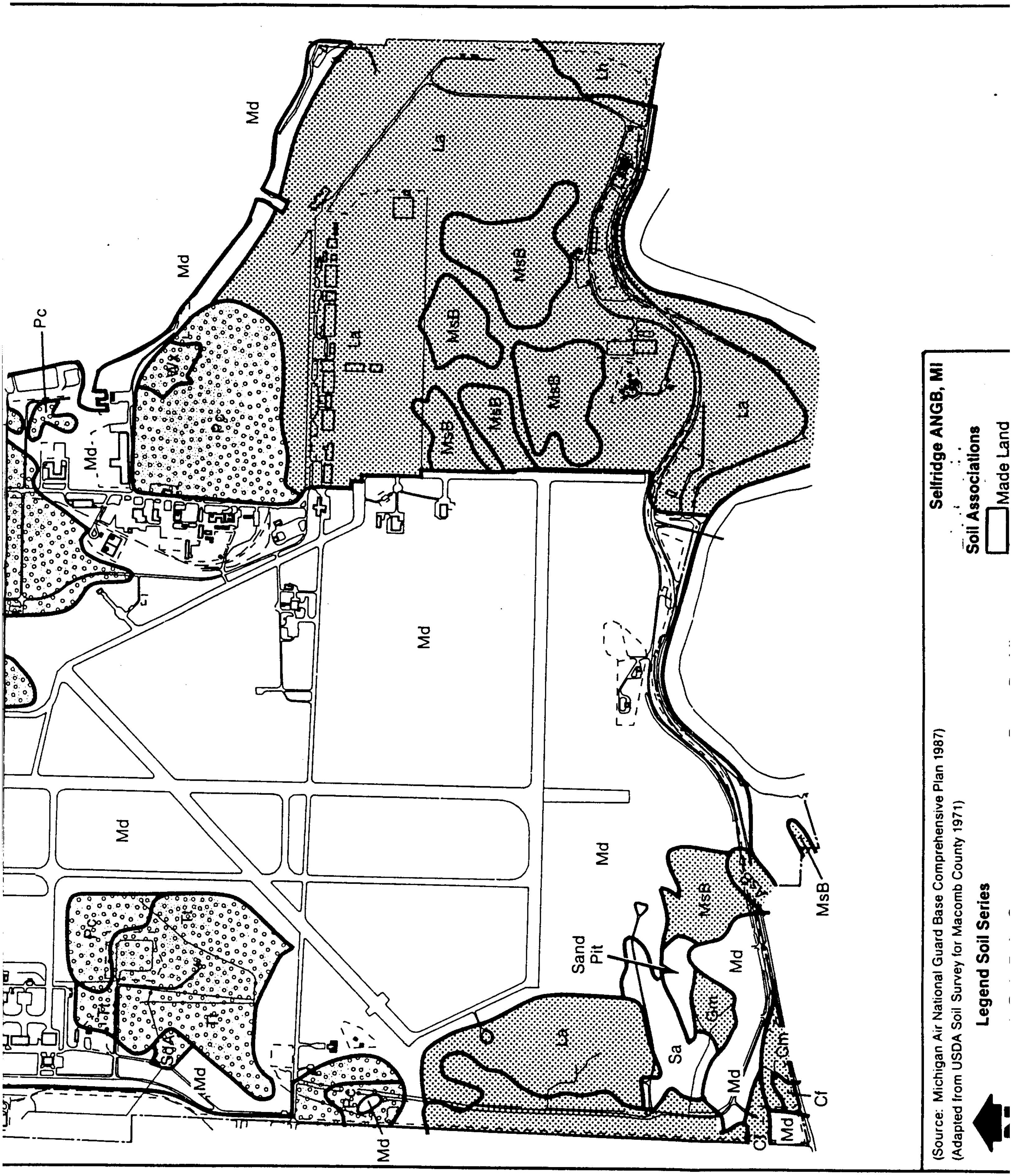


FIGURE 2-3 SOIL SER
FOR SEL

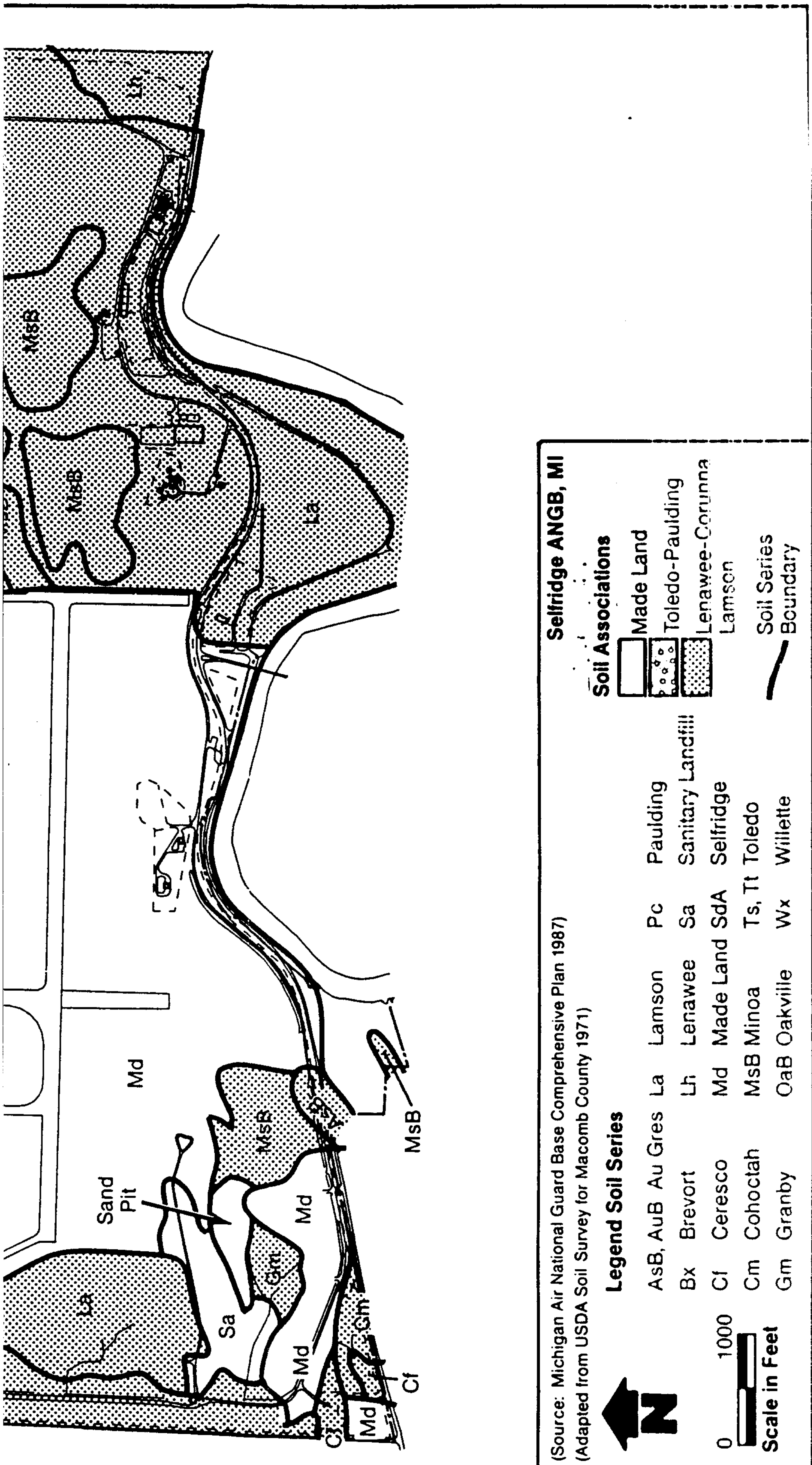


FIGURE 2-3 SOIL SERIES MAP FOR SELFRIDGE ANGB

2.2.4.2 Soil Series Descriptions

The majority of Selfridge ANGB is covered by soil material designated as Made land (Md) (see Figure 2-3). Made land is soil material borrowed from other areas, dumped, and then leveled out, or in-place soils that were significantly disturbed by excavation and regrading. The material can range from clay to sand in texture. In general, the only sign of soil formation is a slight darkening of the surface layer from vegetation. The major soil series that have developed from the lacustrine, marsh, and fluvial sediments at the base include the Paulding series, the Toledo series, the Lamson series, and the Minoa series.

The Pauling series makes up most of the Toledo-Paulding association at Selfridge ANGB. This series consists of the Paulding clay (Pc). These soils occur on lake plains and develop in calcereous lacustrine clay. These soils are poorly drained. Without artificial drainage, areas are wet most of the year due to the high water table, low permeability, and slow runoff.

The other major member of the Toledo-Paulding association at Selfridge ANGB is the Toledo series. This series consists of Toledo clay (Tt) and Toledo silty clay loam (Ts). These soils occur on lake plains and develop in lacustrine clay, silty clay, and silty clay loam. Thin seams of silt and fine sand can be found in these soils. These soils are poorly drained. Without artificial drainage, the water table is near the surface much of the year.

The Lamson series makes up a large part of the Lenawee-Corunna-Lamson association at Selfridge ANGB. These soils are moderately coarse to medium textured. They develop in stratified calcareous silt and very fine sand. These soils are moderately drained, with moderate permeability and infiltration and slow or ponded runoff. The water table in these soils is at or near the surface much of the year.

The Minoa series is the other major series of the Lenawee-Corunna-Lamson association at Selfridge ANGB. The series is made up of the Minoa fine sandy loam (MsB). This soil can occur on lake plains and moraines. This soil is moderately coarse to medium in texture and develops in calcareous fine sand and very fine sand. The Minoa soils are poorly drained, with moderately low permeability and slow runoff.

2.3 HYDROGEOLOGY

2.3.1 Groundwater

2.3.1.1 Occurrence and Movement

Groundwater generally occurs within 15 feet of land surface in the area around Selfridge ANGB and is found within clayey and

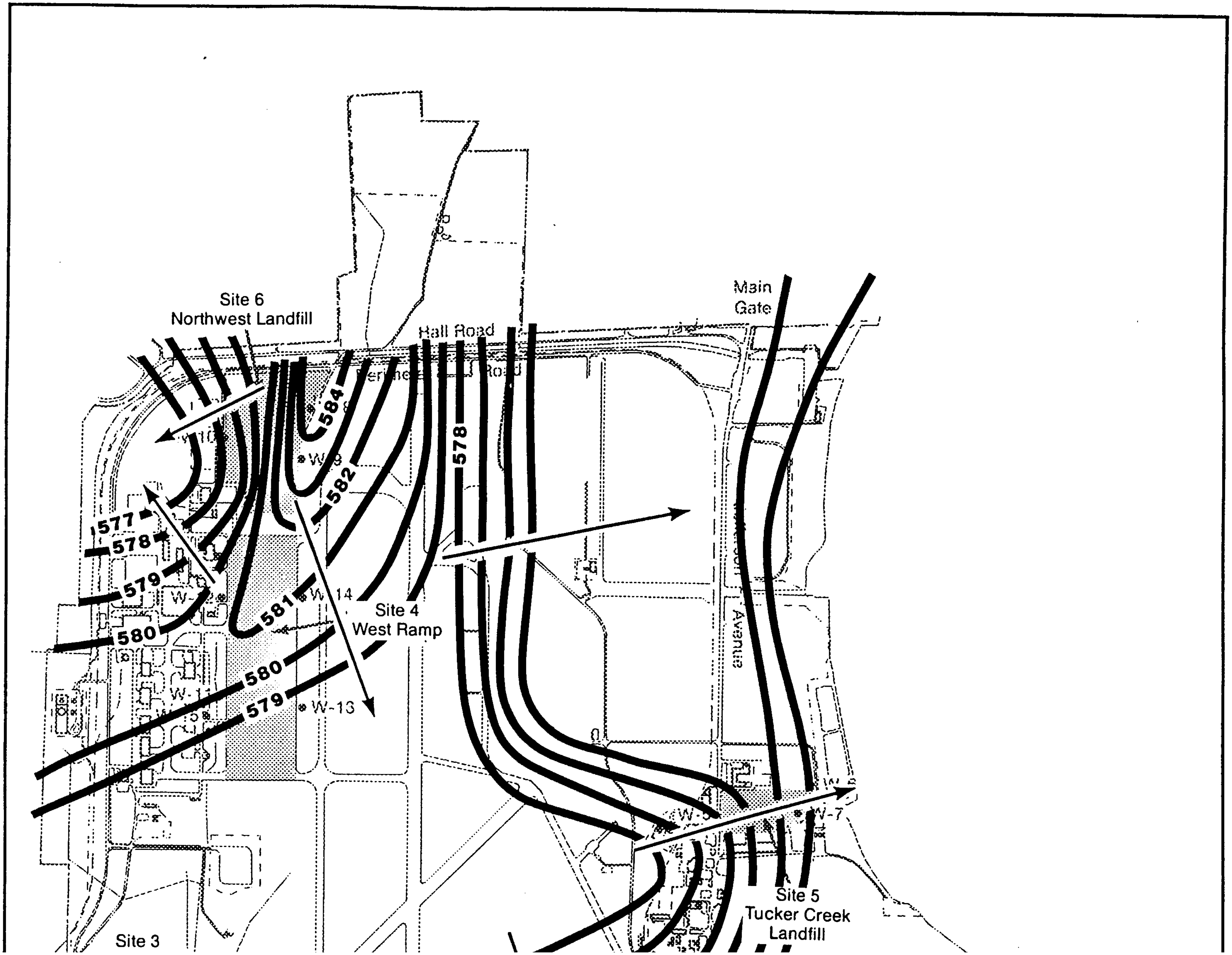
silty unconsolidated Pleistocene Age sediments of glacial and lacustrine origin. Typical yields from wells screened within these sediments are generally less than 10 gallons per minute (gpm). In some parts of the area, thin sand and gravel layers of limited areal and vertical extent can be found at depths greater than 25 feet BLS. Although yields from these coarser-grained layers are generally sufficient for domestic water supplies, the irregular distribution of these layers makes them unreliable as a regionally significant groundwater resource.

Groundwater also occurs in the underlying bedrock formations -- the Antrim Shale and the Traverse Group. However, wells in these formations typically yield less than 10 gpm. In addition, groundwater obtained from these bedrock units is often highly mineralized, making them unsuitable as regionally significant groundwater resources.

Saturated materials were encountered at depth between 8 and 14 feet BLS during the Phase II Stage 1 drilling program at Selfridge ANGB. The static water levels in these wells stabilized within 5 feet of land surface. The static water levels in the Army Corps of Engineers monitor wells, installed during their environmental assessment, stabilized between 4 and 16 feet BLS. An analysis of the Phase II Stage 1 well records suggests that the confining pressure increases approximately 0.8 feet per foot of depth. The water table generally occurs within clayey lacustrine sediments; however, in the southwestern course of the base and along the former strandline at the western edge of the base, the water table occurs in silty to sandy sediments. Groundwater in these coarser sediments was interpreted during the Phase II Stage 1 study as perched on top of the underlying lacustrine clays.

Groundwater in the upper portions of the unconsolidated sediments generally flows toward and discharges to either Lake St. Clair or the Clinton River. Local variations in the direction of groundwater flow exist and may be induced by backfilled excavations, permeability variations, local topographic depressions, and the presence of the stormwater sewer system. Figure 2-4 shows the groundwater flow directions determined from the Phase II Stage 1 study. The groundwater elevation data obtained during the Army Corps of Engineers Environmental Assessment were generally in agreement with the Phase II Stage 1 data. Hydraulic gradients measured at the base during the Phase II Stage 1 investigation ranged from 0.0010 to 0.0076 feet/foot.

Although no direct measurement of hydraulic gradients between the unconsolidated units and the bedrock formations has been made at Selfridge ANGB, groundwater flow is expected to be upward from the rock into the soil. This is based on the structural position of the site at the edge of the Michigan Basin and on the likelihood that Lake St. Clair is a regional groundwater discharge area.



Site 6
Northwest Landfill
Hall Road
Perimeter Road
Main Gate
Avenue
584
582
578
577
578
579
580
581
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W-9
W-14
W-13
W-10
W-7
Site 4
West Ramp
Site 5
Tucker Creek
Landfill
Site 3

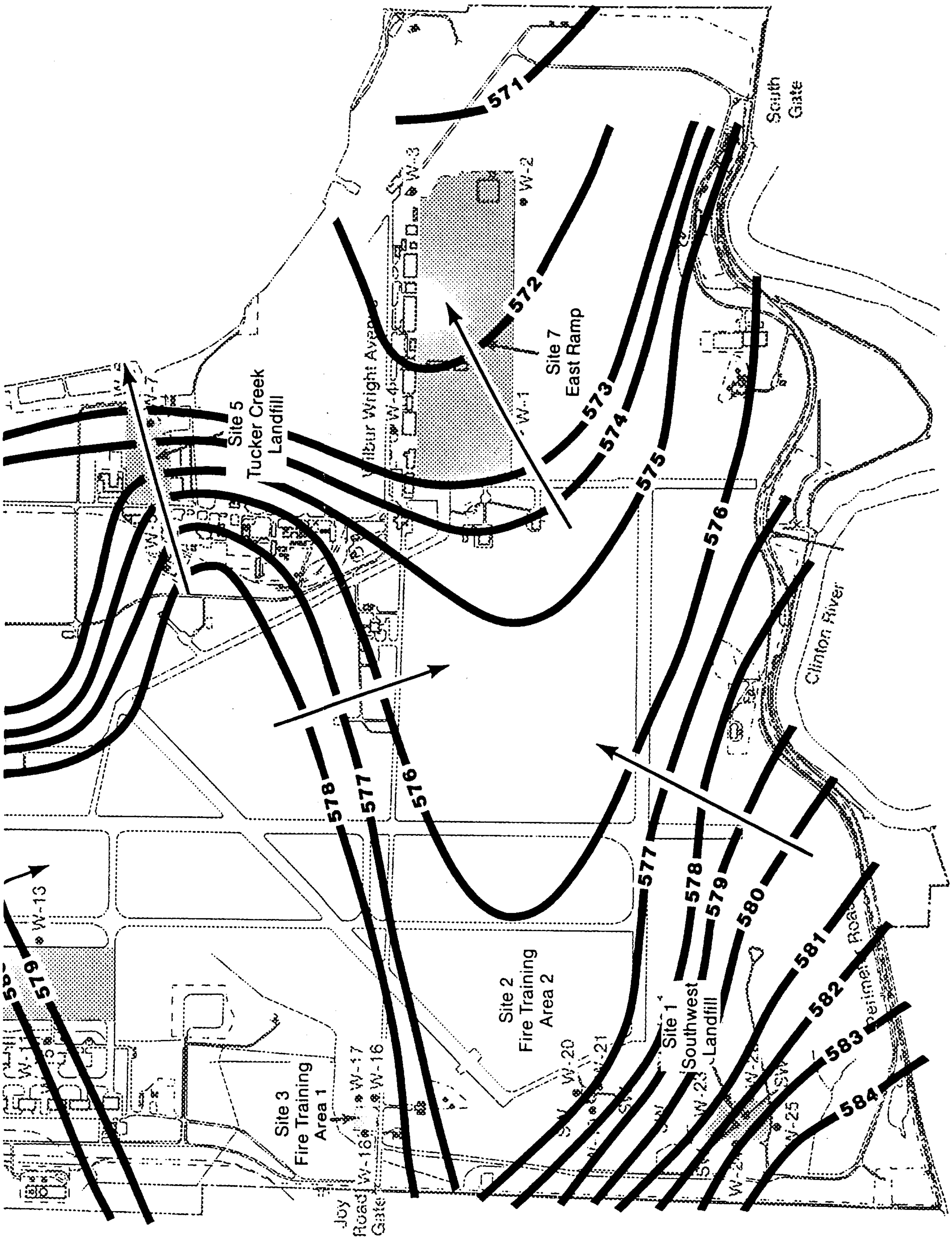


FIGURE 2-4 PHAS
POTE
SELF

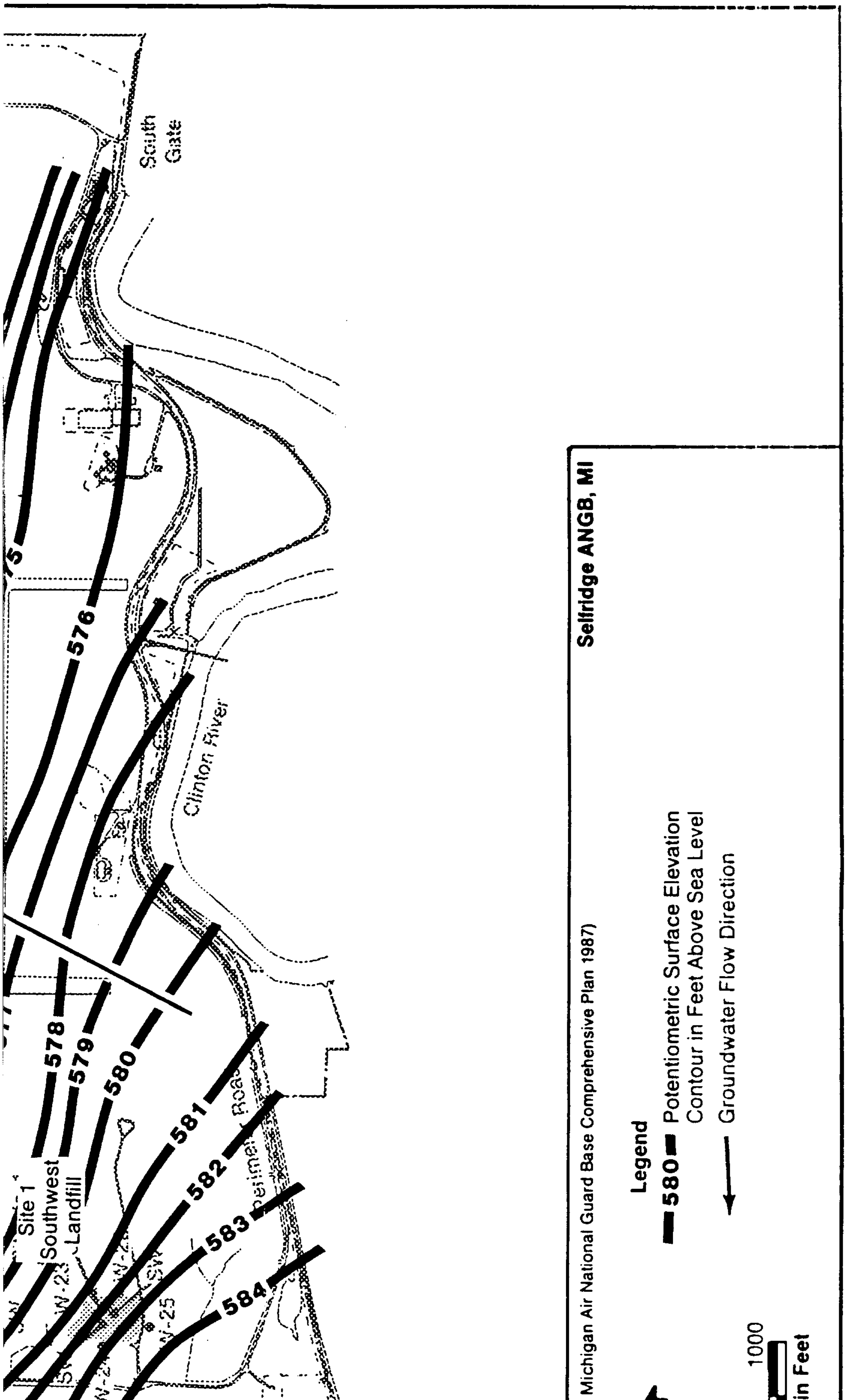


FIGURE 2-4 PHASE II STAGE 1 POTENTIOMETRIC SURFACE MAP, SELFRIDGE ANGB

2.3.1.2 Groundwater Quality

The discontinuous sandy zones within the unconsolidated sediments are a source of potable groundwater in the Macomb County area. However, mineralized water, containing elevated levels of chloride, magnesium, sodium, and potassium, has been produced from some wells in the glacial drift. The highly mineralized groundwater obtained from the Antrim Shale and underlying Traverse Group contains chloride in excess of recommended limits, rendering it unsuitable for domestic, industrial, or irrigation purposes.

The presence of contaminated groundwater identified beneath Selfridge ANGB during the Phase II Stage 1 study appears to be the result of routine aircraft and grounds maintenance activities that have used products containing hazardous and potentially hazardous compounds. The primary compounds of interest are petroleum products, halogenated organic solvents, chlorinated solvents, paint thinners and removers, waste oils, pesticides, and toxic metals.

Substantial quantities of industrial solvents, paint wastes, and petroleum products have been disposed in the landfills on-base. The longevity of the landfill operations, 22 years for Northwest Landfill and 25 years for Tucker Creek Landfill, has created the potential for significant contaminant migration from the source points. Approximately 6,000 gallons of jet fuel has entered the soils around the East and West Ramps due to spills and may also have contributed to the groundwater contamination at the base.

The Phase II Stage 1 investigation found the following concerning groundwater quality at the base:

- Cadmium was the only compound detected in excess of enforcable water quality standards (10 micrograms per liter (ug/L)) in groundwater samples from SWLF (19 ug/L) and TCLF (14 ug/L).

- Groundwater sampled from FTA-2 contained petroleum hydrocarbons at maximum concentrations of 2.4 mg/L and several volatile organic compounds (including benzene) at concentrations of 44 to 51 ug/L. FTA-1 contained similar although lower concentrations of petroleum hydrocarbons.

- Groundwater sampled from ERMP and WRMP contained petroleum hydrocarbons at maximum concentrations of 9.2 mg/L.

- Groundwater sampled from SWLF contained elevated levels of TOC (1,670 mg/L), total phenolics (435 ug/L), COD (3,150 ug/L), petroleum hydrocarbons (113 mg/L), cadmium (19 ug/L), and copper (1,100 ug/L).

- Groundwater sampled from TCLF contained elevated levels of TOC (16.4 mg/L), COD (688 mg/L), cadmium (14 ug/L), copper (1,900 ug/L), and lead (44 ug/L).

- Groundwater sampled from NWLF contained elevated levels of TOC (52 mg/L), COD (565 mg/L), and lead 24 ug/L).

The environmental assessment by the Army Corps of Engineers reached the following conclusions about groundwater quality in an area north of Building 970, near TCLF:

- No detectable concentrations of VOCs, explosives, pesticides, PCBs, total hydrocarbons, sulfide, nor cyanide were found.

- Arsenic (50 ug/L), copper (120 ug/L), chromium (400 ug/L), and lead (80 ug/L) were detected in the groundwater.

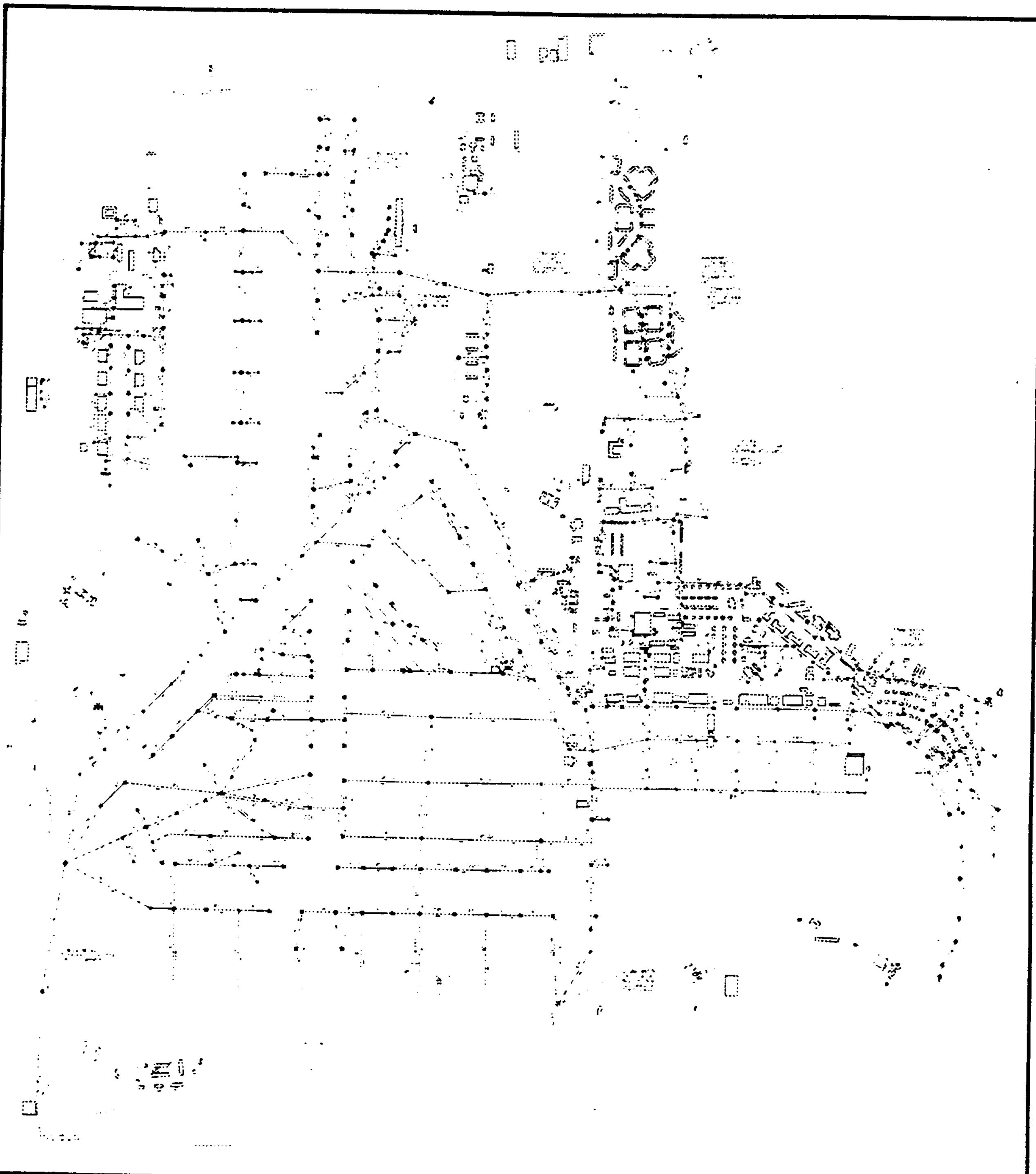
In summary, the groundwater sampled at ERMP, WRMP, FTA-1, and FTA-2 appears to be contaminated by fuel (JP-4), waste solvents, and degreasing solvents from base fuel handling and storage, aircraft degreasing, and fire training exercises. The groundwater from SWLF is contaminated by metals, solvents, and fuels. The groundwater at TCLF and NWLF appears to be contaminated by the same components as SWLF, but to a lesser degree.

2.3.2 Surface Water

The surface water hydrology at Selfridge ANGB is largely controlled by its close proximity to Lake St. Clair. The base is protected from flooding by a system of dikes and drainage ditches. It has, therefore, been excluded from the 100-year floodplain as defined in the 1980 Flood Insurance Study of Harrison Township conducted for the Federal Emergency Management Agency.

2.3.2.1 Surface Water Occurrence and Flow

Due to a lack of relief and natural drainage features on the base, an elaborate system of catch basins, stormwater sewers and pump lift stations were constructed to remove stormwater runoff. Manmade ditches in the base interior help to channel storm water to collection points and to prevent runoff from ponding on the ramps, taxiways, runways, and streets. The primary drainage network is shown in Figure 2-5. Not shown are the intricate secondary network and drain tile system. Storm water drainage collected at the base flows through the storm drainage network to a number of lift stations that pump the storm water runoff into Lake St. Clair and the Clinton River.



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

0 750 1500

Scale in Feet

FIGURE 2-5 STORMWATER DRAINAGE NETWORK, SELFRIDGE ANGB

Along the southern boundary of the base, surface water drains along a ditch, is intercepted by a catch basin, and is ultimately discharged into Lake St. Clair by a lift station. The area north of the base is drained by the Tucker Creek Drain and an unnamed drainage ditch between Hall Road and Perimeter Road that flows into Lake St. Clair.

Inspection of an older topographic map and aerial photographs reveals that surface drainage patterns on the base have been altered through time to accommodate base construction. For example, an improved drainage ditch crossed the center of the base until some time between 1940 and 1951, when it was filled in to allow construction of a new runway complex.

2.3.2.2 Surface Water Quality

Although North River Road is a drainage divide between the base and the Clinton River, the water quality of the river and Lake St. Clair could be affected by surface water from Selfridge ANGB, because lift stations pump water collected in the storm water system into both bodies. The Clinton River has been declared an AOC (area of concern) by the International Joint Commission because of water and sediment contamination (see Subsection 1.3.2.3). The water in Section 1 of the Clinton River has elevated fecal coliform bacteria and total dissolved solids. Sampling of Section 1 of the Clinton River has also detected high metals levels in the water in the main channel.

During Phase II Stage 1 surface water samples were taken from three locations in SWLF and two locations in the FTA-2. The three pond samples at SWLF had maximum concentrations of TOC at 11.5 mg/L and COD at 42 mg/L. Oil and grease was detected at 0.2 mg/L concentration. The two ponds in FTA-2 contained maximum concentrations of 165 mg/L TOC, 147 mg/L phenolics, and 69 mg/L petroleum hydrocarbons. These analyses suggest that leachate from SWLF is degrading the quality of the adjacent surface waters. It is presumed that these surface waters are discharged to the Clinton River.

2.4 NATURAL RESOURCES

2.4.1 Ambient Air Quality

The Michigan Department of Natural Resources Air Quality Division reported on the air quality in Macomb County for the period 1986. During this period the primary National Ambient Air Quality Standards were met for most of the state (see Appendix E).

Measurements for total suspended particulate matter indicated compliance with the primary standards at the four sampled sites in Macomb County. This was a continuation of a 10-year trend in compliance. All sites also met the secondary 24-hour standard for the fourth straight year. The primary carbon monoxide

maximum 8-hour standard of 9.0 parts per million (ppm) was exceeded twice during 1986. The maximum ozone standards was exceeded once during the year at one of two monitoring stations. Over the past 9 years the level of sulfur dioxide has not exceeded either the primary or secondary standard. The quarterly air quality standard for lead was met in 1986, as it had been during the past 8 years.

2.4.2 Mineral Resources

The geology of the Michigan Basin provides a setting for the production of oil and gas, with small production fields occurring along the basin margins in many areas. The production field closest to Selfridge ANGB is approximately 1.5 miles northwest of the base. Production of common table salt also occurs north of the base. Several sand and gravel quarry operations are located within 5 miles both northwest and southwest of the base. During construction of the base, sand was removed from pits located at NWLF and SWLF.

2.5 BIOLOGY AND ECOLOGY

Environmental Control Technology Corporation (1983) reported the following concerning the biota existing on or near Selfridge ANGB.

> Selfridge Air National Guard Base has a limited natural wildlife habitat. The majority of the base area is dedicated to aircraft flight activities (runways, aprons, hangars, etc.), along with necessary roadways, parking areas, and operational and residential buildings. There is also a considerable area in the southeastern portion of the base dedicated as a golf course. There are no significant surface water resources on the base itself.
>
> No data base was available with respect to the fauna to be found on the base property specifically. It can be assumed, however, that bird and wildlife generally associated with this region could be found on-site. These would include:

- Birds:
  - American Robin
  - Common Grackle
  - Starling
  - House Sparrow
  - Brown Cowbird
  - Barn Swallow
  - Cardinal
  - Red-Winged Blackbird
  - Bluejay
  - Song Sparrow
  - Killdeer
  - Common Flicker
  - Common Crow
- Mammals:
  - Oppossum
  - Shorttail Shrew
  - Eastern Gray Squirrel
  - Eastern Fox Squirrel

- Pygmy Shrew
- Eastern Mole
- Raccoon
- Spotted Skunk
- Striped Skunk
- Red Fox
- Woodchuck
- 13-Lined Squirrel
- White-Footed Mouse
- Deer Mouse
- Meadow Vole
- Pine Vole
- Eastern Cottontail
- White-Tail Jackrabbit
- White-Tail Deer
- Eastern Chipmunk

The relatively high activity level on the base precludes its being a permanent habitat for the larger mammal species, although all are known to occur on a transient basis around the base property.

Given the lack of terrestrial and aquatic habitats on-site and the highly developed areas adjacent to the site, no protected species are likely to occur on or near the site.

2.6 CLIMATOLOGY/METEOROLOGY

2.6.1 Climate

The climate of southeastern Michigan is classified as humid continental to semimarine. It is dominated by continental polar air masses in the winter and tropical air masses in the summer. Intensely contrasting seasonal temperature changes, highly variable weather, and abundant precipitation throughout the year result from the interaction of these air masses along cold fronts associated with east-moving cyclones.

2.6.2 Precipitation

Average annual precipitation at Selfridge ANGB for the period 1939 through 1987 was 29.34 inches, generally distributed evenly throughout the year. Summer precipitation occurs in the form of afternoon showers and thundershowers spawned by migratory frontal activity. Greater than one-half of the total yearly precipitation falls during the period from May to October. The greatest monthly amount of precipitation is usually received during June. Snowfall in this area averages 30 inches per year. The majority of infiltration and groundwater recharge occur during the spring and fall. This is because evaporation exceeds precipitation in the summer, and frozen ground prevents infiltration during the winter.

2.6.3 Temperature

The mean yearly temperature at Selfridge ANGB for the record period 1938 through 1987 is 48.3°F. Monthly average temperatures range from 24°F in January to 72°F in July. Maximum and minimum temperatures for this period were 100 and -13°F, respectively. The average dates of the first and last freezing

temperatures are 14 October and 1 May, respectively. Temperatures at the base are moderated somewhat by the presence of Lake St. Clair.

2.6.4 Wind

Prevailing winds at Selfridge ANGB are westerly. During the summer months the predominant wind direction is southwesterly. During the winter months the prevailing wind direction shifts to a westerly to northwesterly pattern. Daily and weekly wind directions shift frequently due to the sizable variation of high and low pressure systems moving across the Midwest.

2.6.4 Evapotranspiration

Data collected from a class "A" evaporation pan at Dearborn, Michigan, indicate that evaporation potential during the growing season is about 35 inches. This is greater than twice the average amount of precipitation for this period. However, on an annual basis, evaporation and precipitation are about equal.

2.7 INFORMATION SOURCES

The information presented in this section was derived from a variety of sources. Subsection 2.1 was prepared using U.S.G.S topographic maps, the work by Fenneman on the physiography of the United States, and information provided by the Macomb County Chamber of Commerce and the Macomb County Planning Commission. Subsections 2.2 and 2.3 were prepared using the IRP Phase I report, the IRP Phase II Stage 1 report, publications of the Michigan DNR Geological Survey Division, and the Soil Survey for Macomb County. Subsection 2.4 was prepared using air quality reports from Michigan DNR, U.S.G.S topographic maps, and information from previous IRP reports. Subsection 2.5 was taken entirely from the IRP Phase I report (ENCOTEC, 1983), and Subsection 2.6 was prepared using information from the Soil Survey for Macomb County, data provided by Selfridge Detachment 12, 15th Weather Squadron, and data obtained from the National Oceanic and Atmospheric Administration (NOAA).

SECTION 3

FIELD INVESTIGATION PROGRAM

3.1 ORGANIZATION AND DEVELOPMENT OF THE FIELD PROGRAM

On 25 September 1987 WESTON was authorized to conduct an IRP Stage 2 study at Selfridge ANGB under U.S. Air Force contract No. F33615-87-D-4018, Delivery Order 0002. The scope of the order was based on the recommendations of WESTON's Phase II Stage 1 investigation completed in October 1986, which indicated the need for follow-up investigation focusing on:

- Expanding the monitoring and sampling program to evaluate the nature and extent of priority pollutant and petroleum hydrocarbons compound contamination at each of seven IRP sites (plus an additional site requested for investigation by the base).

- Evaluating potential contaminant migration pathways, including a qualitative assessment of risks to human health or the environment.

- Performing preliminary feasibility studies, including identifying possible remedial response actions, initially screening remedial technologies, and developing remedial alternatives.

The ultimate objective of the IRP is the identification and implementation of appropriate remedial actions for each IRP site. Toward this end, the IRP Stage 2 effort set forth in the SOW consisted of three principal elements:

- Remedial investigation.
- Qualitative risk assessment.
- Preliminary feasibility study.

3.1.1 Remedial Investigation

3.1.1.1 Original Statement of Work

The SOW issued by USAFOEHL on 25 September 1987 directed WESTON to investigate eight sites at Selfridge ANGB by completing the following tasks:

- Drill a maximum of 29 soil borings, each extending 30 feet.

- Install a maximum of 39 monitor wells, including 22 shallow wells, each extending 15 feet, and 17 deep wells, each extending 35 feet.

- Develop the newly installed monitor wells and existing IRP Stage 1 monitor wells.
- Test all IRP monitor wells to determine hydraulic conductivity.
- Establish 24 surface water sampling locations at stormwater drains, surface ponds, and stormwater lift stations.
- Collect a maximum of 93 investigative soil samples.
- Collect a maximum of 62 investigative groundwater samples.
- Collect a maximum of 48 surface water samples, two rounds of 24 samples each under two conditions; the first round after a non-freezing precipitation event, and the second after a significant dry period.
- Abandon two existing IRP Stage 1 wells (04-114 and 02-120) damaged by base operations.
- Measure water levels in monitor wells throughout the base.
- Install six continuous water level recorders, three at stormwater drains, and three at adjacent monitor wells.
- Record 12 consecutive weeks of water levels from the 3 pairs of continuous water level recorders.
- Determine the elevations and locations of all newly installed IRP Stage 2 monitor wells, existing IRP Stage 1 monitor wells, continuous water level recorder stations, and all surface water sampling stations by a certified land surveyor to third-order accuracy.

3.1.1.2 Modifications to the Statement of Work

After a site visit on 28 and 29 October 1987 by representatives of WESTON, USAFOEHL, and Selfridge ANGB, several modifications to the SOW were suggested by WESTON and submitted to USAFOEHL in a letter on 16 November 1987. The modifications included:

- Abandoning three additional shallow IRP monitor wells (05-106, 02-119, and 02-121) that were found to be damaged and unusable.
- Replacing the abandoned wells with shallow monitor wells completed as described in the Work Plan and Quality Assurance Project Plan.

- Modifying 10 existing IRP Stage 1 wells from flush-with-grade to stick-up completions, including monitor wells 07-101, 07-102, 07-103, and 07-104 at East Ramp; 05-105 and 05-107 at Tucker Creek Landfill; 06-110 at North West Landfill; and 04-111, 04-112, and 04-113 at West Ramp.

- Installing all new IRP monitor wells as stick-up completions -- 24 flush-with-grade completions had been assumed.

- Repairing three stick-up completions at Fire Training Area 1 by the addition of guard posts and unitary pads.

These modifications were approved by USAFOEHL and incorporated into the SOW. Implementation of the Scope of Work is discussed on a site-by-site basis in Subsections 3.4, 3.5, and 3.6.

3.1.2 Qualitative Risk Assessment

Collecting the data necessary to perform a qualitative risk assessment was integrated into the Scope of Work. A risk assessment is a qualitative or quantitative approach for determining the upper boundary of risk to the "maximally exposed" and/or "average exposed" human or critical environmental receptors associated with contamination present at a site. The effort described for Selfridge ANGB was designed to identify risks that could result from a particular site on the basis of existing conditions.

In order for chemicals to pose a risk to public health or to the environment, two factors must exist simultaneously. The substance must be toxic to a particular receptor at a specified concentration, and there must be some chance that a receptor can come into contact with the substance in sufficient amount for it to be toxic to the receptor.

The qualitative risk assessment for this study (IRP Stage 2) addresses the toxicity and quantity of substances released from sites on the base and the chance and degree of human or environmental exposure. All pertinent data collected under IRP site characterization studies, including Phase I, Phase II Stage 1, and IRP Stage 2, have been incorporated in the qualitative risk assessment.

The objectives of the qualitative risk assessment are as follows:

- Identify the physical and chemical characteristics of the contaminants of concern at each site (e.g., toxicity, carcinogenicity, flammability, etc.).

- Identify release mechanisms (e.g., volatilization, leaching) and, if appropriate, estimate the volume of contaminants released or being released at each IRP site.

- Identify potential human and environmental receptors and receptor characteristics that might increase vulnerability to the effects of contaminants.

- Determine potential contaminant exposure pathways (e.g., direct contact, inhalation of vapors/dust, ingestion of contaminated water or soil, ingestion of aquatic organisms).

- Determine representative migration rates associated with individual sites. Rates of flow, groundwater velocities, and times necessary to reach receptors will be calculated based on a range of conservative assumptions.

Based upon these findings, sites are to be ranked as those that pose an immediate and direct health hazard, those that require further investigation, and those that have no significant impact upon human health and welfare or the environment. The qualitative risk assessment associated with the IRP Stage 2 investigation is detailed on a site-by-site basis in Subsections 4.4 through 4.11.

3.1.3 Preliminary Feasibility Study

A feasibility study designed to develop preliminary remedial action alternatives on a site-by-site basis was performed as part of the IRP Stage 2 study. The general approach for the preliminary feasibility study included the following steps:

- Identification of general response actions including "no action."

- Identification of available remedial technologies by waste type and media.

- Screening available technologies to identify those applicable to site conditions.

- Identification of operable units, where possible.

- Development of remedial alternatives based on the applicable technologies and operable units identified.

The preliminary feasibility study is described in Section 5 of this report.

3.2 DATA QUALITY OBJECTIVES

The overall quality assurance objective for field activities, data analyses, and laboratory analyses was to produce data of sufficient and known quality to support evaluation of environmental effects and selection of remedial alternatives. Specifically, all data were to be gathered or developed using procedures appropriate for the intended use. The Quality Assurance Project Plan (QAPP), which is included in Appendix F, detailed these standard procedures. Included in the following QAPP subsections are methods protocols for test borings and exploratory drilling (see Subsection 2.1); monitor well installation and testing (see Subsection 2.2); water level data collection (see Subsection 2.3); sample collection (see Subsection 2.5); decontamination procedures (see Subsection 2.6); sample handling (see Subsection 2.7); sampling QA/QC (see Subsection 2.8); and sample custody, documentation, and shipping procedures (see Subsection 1.6). Calibration of field and laboratory instruments is detailed in Subsection 1.7 in the QAPP. Laboratory procedures and laboratory certifications are listed in Subsections 1.8 through 1.15 of the QAPP and in the Laboratory Standard Practices Manual in Appendix A of the QAPP. Table B-1 in the QAPP lists the analytical methods, parameters, and limits of detection for all analyses for samples taken from Selfridge ANGB. The above-referenced standard procedures were used so that known and acceptable levels of accuracy, precision, representativeness, completeness, and comparability were maintained for all data sets.

Except for samples that required dilution because of high contaminant concentrations, the limits of detection specified in the QAPP were met by the laboratory. In all cases, the detection limits (listed in Table B-1 of the QAPP) used for this study were less than the corresponding Federal or state standards (listed in Table 1-3 of the QAPP) to allow comparison of the analytical results with those standards. Applicable Federal and State criteria for the compounds of concern at Selfridge ANGB are addressed in Subsection 4.3 of this report.

3.3 IMPLEMENTATION OF FIELD PROGRAM AND SUMMARY OF FIELD WORK PERFORMED

The IRP Stage 2 field investigation began on 14 December 1987 and was completed on 9 September 1988. The field work was performed in accordance with the approved QAPP. A list of each major field activity and the period during which it occurred is presented in Table 3-1. Subsection 3.3.1 discusses the sequence of these field activities, and Subsection 3.3.2 discusses the subcontractors used.

3.3.1 Time Sequence of Work Performed

The first period of field work extended from 14 December 1987 to 23 December 1987. The field activities performed during this

WESTON

Table 3-1

Time Sequence of Field Work Activities,
IRP Stage 2, Selfridge ANGB, MI

Activity	Time Frame
Mobilization	14 Dec 87 to 17 Dec 87
Drilling soil borings	17 Dec 87 to 11 Jan 88
Groundwater monitor well installation	11 Jan 88 to 6 Apr 88
Development and baildown recovery tests	18 Jan 88 to 13 Apr 88
Continuous water level recorders	16 Feb 88 to 16 May 88
Groundwater sampling	4 Apr 88 to 23 Apr 88
Surface water sampling -- dry-event	20 Apr 88
Surface water sampling -- rain-event	9 May 88 to 11 May 88
First resampling	20 Jun 88 to 21 Jun 88
Second resampling	1 Aug 88 to 10 Aug 88
Surveying (second subcontractor)	22 Aug 88 to 9 Sep 88

Note: Dates reflect time of initiation and time of completion.

period included general mobilization of equipment and supplies to the base, establishment of the field office, and drilling and sampling of soil borings. WESTON mobilized on 14 December 1987, but poor weather (snowstorm) delayed mobilization by the drilling subcontractor until 17 December 1987. Drilling and sampling of soil borings began on 17 December 1987 and continued through 23 December 1987. On 23 December 1987 field activities were shut down for the Christmas and New Year's holidays.

The second period of field work extended from 4 January to 10 February 1988. During this period field activities included drilling and sampling of soil borings, installation of monitor wells, development of monitor wells, and baildown recovery testing of monitor wells. Drilling and sampling of soil borings resumed on 4 January and was completed by 11 January 1988. Installation of monitor wells was begun on 11 January and continued through 6 February 1988. Development and baildown recovery testing of monitor wells was started on 18 January and continued through 10 February 1988.

The third period of field work extended from 16 February to 20 February 1988. During this period the continuous water level recorders were installed. From 3 March to 5 March 1988 -- the fourth period of field work -- the operation of the continuous recorders was checked, required maintenance and repairs were performed, some additional development and baildown recovery testing was done, and water levels were measured in monitor wells throughout the base.

The fifth period of field activity extended from 21 March to 26 April 1988. The field activities performed during this period included installation of monitor wells, development of monitor wells, baildown recovery testing of monitor wells, groundwater sampling, and dry-event surface water sampling. Installation, development, and baildown recovery testing of monitor wells were resumed on 21 March 1988. Monitor well installation was completed on 6 April 1988. Development and baildown recovery testing were completed on 13 April 1988. Groundwater sampling was started on 4 April and finished on 23 April 1988. The dry-event surface water sampling took place on 20 April 1988, after 8 days without significant precipitation. Field QA/QC audits were performed from 23 March to 24 March 1988 and from 7 April to 8 April 1988. Activities between 23 April and 26 April 1988 included placement of permanent markers at soil boring locations, restoration of landscaping at soil boring and monitor well locations, and painting bumper posts and well casings in accordance with the base color scheme.

The sixth period of field work covered two 3-day efforts in May 1988. From 9 May to 11 May 1988 the wet-event surface water sampling was performed, and water levels were measured in all IRP monitor wells. From 16 May to 18 May 1988 the continuous

water level recorders were removed and the field office was demobilized. A 2-day field effort occurred from 20 June to 21 June 1988, during which selected monitor wells were resampled because sample holding times had been exceeded.

The next period of field work extended from 1 August to 10 August 1988. This effort involved additional resampling of monitor wells and surface water locations to correct for additional sample holding time exceedances. The final period of field work extended from 22 August to 9 September 1988. During this period the second surveying subcontractor -- hired in August 1988 after failure of the initial subcontractor to perform -- conducted the third-order survey of all soil boring, monitor well, surface water sampling, and continuous recorder locations.

3.3.2 Identification and Role of Subcontractors

Exploration Technology, Inc. (ETI) of Madison, Wisconsin, was contracted to drill the soil borings; install the monitor wells; modify the flush-mounted, previously installed IRP wells to stick-up completions; and install unitary pads and bumper posts. To complete these tasks ETI mobilized three drilling rigs and a crew of seven to operate the rigs and perform equipment decontamination using the ETI steam cleaner.

Grant Ward Surveying of Holly, Michigan, was contracted to survey all monitor wells, soil borings, surface water stations, and continuous water level recorders for elevation and location. Elevations at the tops of the well casings, protective casings, and elevations of the surrounding ground surface were surveyed at each well location. The surface water stations were surveyed by staff gage locations or filed indentations in the storm sewers. The soil borings were surveyed relative to permanent markers cemented in the ground. Two 2-man crews were mobilized to complete these tasks.

3.4 DRILLING, SOIL BORING, AND MONITOR WELL INSTALLATION

3.4.1 Drilling Techniques and Equipment

Three ETI drilling rigs, a Central Mining Equipment (CME) 55 truck-mounted rig, a CME 550 tractor-mounted rig, and a CME 750 tractor-mounted rig were used at Selfridge ANGB for the IRP Stage 2 drilling program. In accordance with Subsection 2.1 of the approved QAPP, the soil and well borings established at the base were drilled with 4.25-inch inside diameter (ID) hollow-stem augers (HSA), and continuous soil samples were obtained with either a standard split-spoon or a 5-foot CME continuous sampler.

A 6- to 12-inch frost zone prevented the continuous sampler from being used for the initial 1 to 2 feet of many of the boreholes. In these situations, the lead auger was advanced just

beyond the frozen material, the auger was withdrawn from the borehole and detached from the drive head, and the frozen soil plug was removed from the auger. The continuous sampler could then be used for the remainder of the borehole. Even when this method was used to penetrate the frost zone, sample recovery in the upper 5 feet of soil was usually less than 50 percent. This was due to the inability of the continuous sampler to effectively penetrate and collect the coarser fill material encountered near the surface. In several instances, when little or no sample was recovered in the initial 10 feet of drilling and if detailed stratigraphic information was deemed necessary for the unrecovered interval, a split-spoon sampler was driven adjacent to the established borehole. A split-spoon sampler was also used in many of the soil borings drilled at the West Ramp and Tucker Creek Landfill due to the unavailability of the continuous samplers during the initial 10 days of the drilling program.

Each split-spoon sample or 5-foot soil core was examined in the field by a WESTON geologist, who provided a written description and classified the material in the core according to the Burmeister and the Unified Soil Classification System (USCS). This information was recorded on an IRP boring log, which was completed for each soil and well boring (see Appendix G). A maximum of three soil samples were retained from each soil boring for laboratory analysis in accordance with the procedures described in Subsection 2.5.3 of the QAPP and Subsection 3.6.1 of this report. Analytical testing of the soil samples is described in Subsection 3.7 of this report. Drilling and sampling equipment was decontaminated between boring locations using the procedure set forth in Subsection 2.6 of the approved QAPP.

An OVA (organic vapor analyzer) or HNu photoionization meter was used during drilling to monitor the borehole and breathing zone for total volatile organics (TVO) and to scan the soil samples for TVO in accordance with Subsection 2.1 of the approved QAPP. If high readings were obtained from the borehole on the OVA, a combustible gas indicator (CGI) was used to determine explosive potential by measuring the percentage of the lower explosive limit (percent LEL). Instrument readings were recorded on a downhole measurement sheet for each soil and well boring. The TVO levels that dictated a specified level of personnel protective clothing (action levels) were detailed in the Selfridge IRP Stage 2 Health and Safety Plan. These action levels were adhered to during the drilling program. All work during the drilling program was performed in Level D protection, with the exception of three soil borings at FTA-2 and one well at Southwest Landfill, where Level C protection was used.

Soil borings were tremie grouted from the bottom of the borehole to the surface with a cement-bentonite grout to prevent downward migration of contaminants through the open borehole, as specified in Subsection 2.1.1 of the approved QAPP. Borehole

cuttings were not used to backfill any of the soil borings. Uncontaminated drill cuttings were placed in a neat pile around each borehole, as requested by the Base Point-of-Contact (POC) and Base Civil Engineer. Although drill cuttings from many of the boreholes initially registered OVA readings above 5 units -- the action level set in Subsection 2.1 of the approved QAPP for containerization of drill cuttings -- these levels dissipated to below 5 units overnight and the cuttings were considered uncontaminated for the purpose of disposal, especially since the organic vapors were judged to be naturally occurring methane.

The soil boring locations were permanently marked with aluminum dome-top markers set in concrete. Each marker has the boring number imprinted on the top for the purpose of identification.

3.4.2 Well Construction and Development

3.4.2.1 Well Construction

Forty-two borings were drilled to install groundwater monitor wells at Selfridge ANGB during the IRP Stage 2 field program. These borings were established according to the same protocol described in Subsection 3.4.1 of this report and Subsection 2.1 of the approved QAPP. Continuous soil samples were obtained from each borehole, were described and classified, and were scanned with an OVA detector. Well boring logs and downhole measurement sheets are presented in Appendix G. Archive samples retained for lithologic reference were collected at 2.5-foot intervals from at least one deep well at each of five sites and from one shallow well at each of two sites where no deep wells were drilled. The wells archived include 01-259, 01-261, 02-166, 04-253, 04-255, 05-231, 06-245, 07-239, 08-128. No wells were installed at FTA-1 (Site 3) during the current study.

Subsection 2.2.1 of the approved QAPP called for each shallow well to be positioned with 7 feet of screen below and 3 feet of screen above the water table. The base of the adjacent deep well was to be set generally 20 feet below the base of the shallow well as described in Subsection 2.2.2 of the approved QAPP. The location of the water table was determined by observations of the soils during drilling at each well installation. An increase in soil discoloration (mottling) was noted in the soils as the water table depth was approached. The discontinuation of the soil mottling and the saturation of the soils below the mottling change confirmed the location of the water table.

Field conditions required that modifications be made to well construction specifications. Greater groundwater confining pressure than anticipated in the shallow aquifer underlying the base became evident during installation of the initial Stage 2

wells and during the soil boring program. As a result, the majority of the shallow wells were installed with 5 feet of screen above and 5 feet below the water table. Eight of the 16 deep wells established at the base were installed to a depth of less than 20 feet below the adjacent shallow wells due to the presence of a dry, hard, sand and gravel till layer. The top of the hard till was encountered between 26 and 35 feet at four sites: West Ramp, Tucker Creek Landfill, Northwest Landfill, and Southwest Landfill. Well completion sheets, showing the construction details of each well, are presented in Appendix G. A typical groundwater monitor well is shown in Figure 3-1.

In accordance with Subsection 2.2.1 of the approved QAPP, all wells are constructed of 2-inch ID, Schedule 5, #304 stainless steel casing and screen and possess flush-threaded joints, caps, and end-plugs. A 10-foot, 0.010-inch, continuous-slot well screen was used in all wells. Prior to installation these well screens and casings were steam cleaned as specified in Subsection 2.6.1 of the approved QAPP. In accordance with the approved modifications for well completion, the well casings project above the ground surface by 1.67 to 2.70 feet. Exactly 2 feet of stick-up was not attainable at all well locations because of the need to set wells at a particular depth.

A #30 sand filter pack (packaged and sold by Red Flint Filter Sands & Gravels) was installed in the annular space around the well screen to a height of at least 2 feet and no more than 5 feet above the top of the screen. During emplacement of the sand pack, the augers were withdrawn only 2 to 5 feet at a time, and the depth to the sand pack was checked frequently to ensure that no open borehole was present between the top of the sand pack and the bottom of the augers. The sand was added slowly to minimize the possibility of sand bridging between well and augers.

A minimum 2-foot thick seal, consisting of bentonite granules, pellets, or slurry, was installed above the sand pack. The remaining annular space was filled with a 4:1 cement-bentonite grout using a tremie pipe. A 4-inch diameter, steel protective casing with a locking cap was placed over the stainless steel well casing of each well. Steel bumper posts 8 feet in length were installed to protect the newly installed wells. Bumper posts extended from 18 inches to 3 feet above the ground surface. Three bumper posts were placed around single shallow wells, while five or six bumper posts were installed around well nests. A 4- to 6-inch thick concrete pad, sloping away from the wells, was installed around the well and bumper posts at each location. This configuration of protective casing, bumper posts, and concrete pad was consistent with the approved modification for well completion. The number of each monitor well was permanently marked on the protective casing with paint

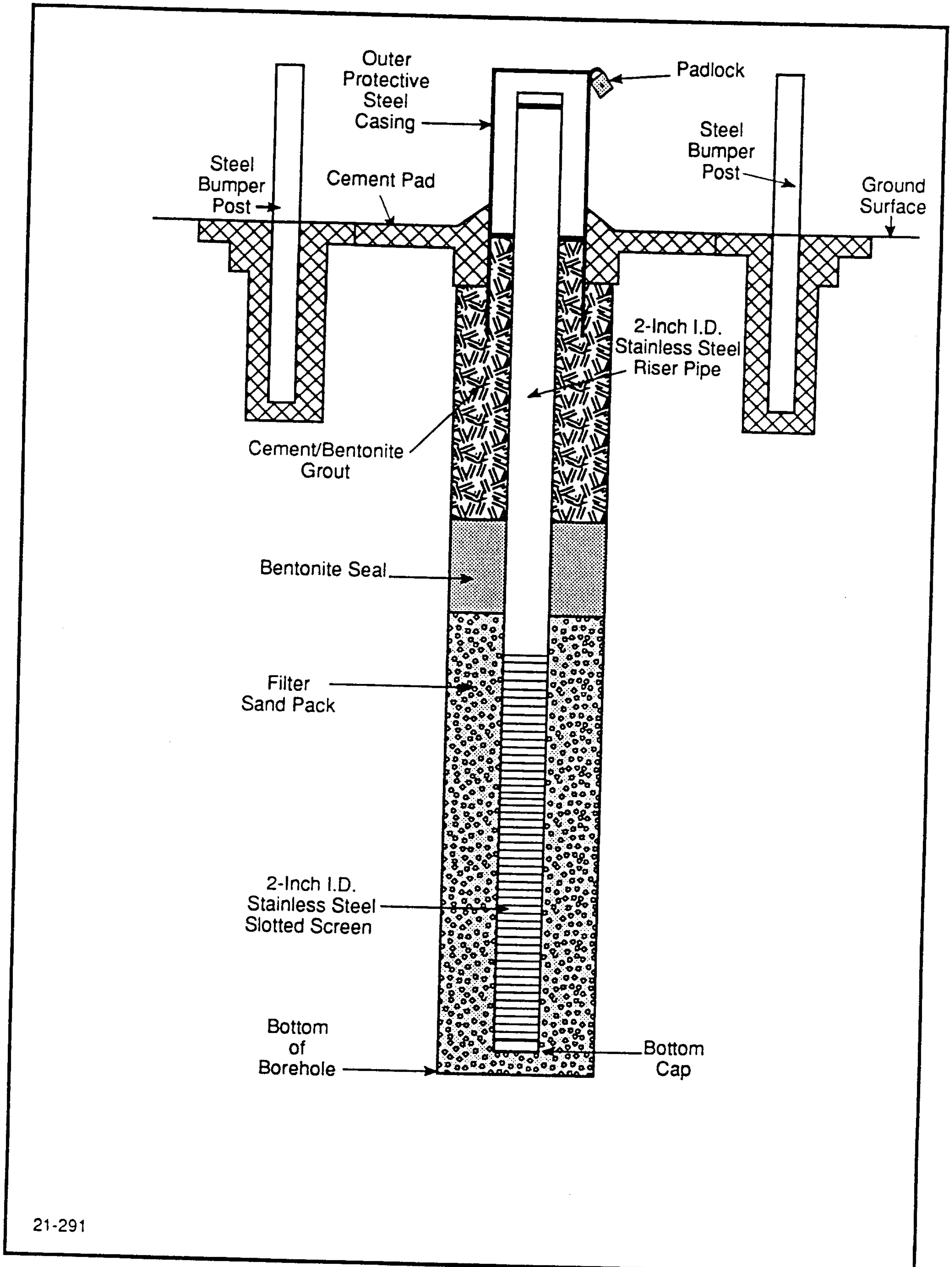


FIGURE 3-1 TYPICAL CONSTRUCTION DETAILS FOR A MONITOR WELL, SELFRIDGE ANGB

as well as with hand-stamp steel dies. Bumper posts and well protective casings were also painted to provide better visibility.

3.4.2.2 Well Development

All IRP monitor wells at Selfridge ANGB were developed during the current study, including those installed during IRP Phase II Stage 1. Redevelopment of existing wells was performed to clear sediment that had collected in the well and sand pack. Development of newly installed wells removed the drill cuttings and set the sand pack around the screen. The steps followed in well development were as follows:

- Static water level was recorded.
- Depth to the bottom of the well was recorded.
- Standing water column and volume were calculated.
- Water was removed from the well using a decontaminated PVC bailer.
- Well was surged using bailer while water was being removed.
- Volume purged was measured and recorded.

Redevelopment of existing wells consisted of taking out at least three well volumes. These wells were bailed dry one to five times. Development of newly installed wells consisted of taking out at least five well volumes. New wells were bailed dry two to five times. Criteria for determining that development was complete included the removal of a minimum number of well volumes as stated above and evidence of satisfactory responsiveness as indicated by recovery test water level measurements. These procedures were consistent with Subsection 2.2.3 of the approved QAPP. A summary of well development data can be found in Table 3-2.

3.4.3 Number of Soil Borings and Monitor Wells Installed

Twenty-nine exploratory soil borings were drilled and 42 monitor wells were installed at Selfridge ANGB during the IRP Stage 2 field program. A detailed listing of soil boring and monitor well numbers by site is given in Table 3-3. Locations of all IRP monitor wells upon completion of the IRP Stage 2 investigation are shown in Figure 3-2.

Subsections 3.4.3.1 through 3.4.3.8 discuss, on a site-by-site basis, the IRP Stage 2 soil boring and monitor well installation program. Subsection 3.4.4 presents a footage summary of the IRP Stage 2 drilling.

Table 3-2

Well Development Data,
IRP Stage 2, Selfridge ANGB, MI

Well Number	Depth to Water: Inner Casing (ft)	Depth to Water: Outer Casing (ft)	Depth to Bottom of Well (ft)	Volume: in Well (gals)	Volume: Evacuated (gals)	Number of Times Well Bailed Dry	Notes
01-122	4.90	4.98	24.80	3.32	20.0	0	Silty, gray/brown water
01-123	4.50	4.58	18.37	3.82	15.0	5	Silty, gray/brown water
01-124	4.76	4.87	25.46	3.46	18.0	3	Silty, gray/brown water
01-125	5.84	5.95	27.27	3.58	19.0	3	Silty, gray/brown water
01-156	4.50	4.53	19.16	2.44	13.0	2	Very heavily silty, brown water
01-158	4.92	5.01	16.18	1.88	17.0	0	Very silty, brown water
01-257	8.44	8.53	38.27	4.90	25.0	8	Very heavily silty, gray water
01-259	26.30	26.41	37.82	1.92	9.0	4	Silty, brown water
01-160	5.29	5.96	20.89	2.50	18.0	2	Slightly silty, brown water
01-261	32.37	32.48	35.87	0.58	3.5	2	Silty, brown water
01-162	5.72	5.92	17.92	2.03	14.0	2	Slightly silty, cloudy water
01-263	14.85	14.89	38.00	3.86	15.0	5	Silty, brown water
02-164	13.04	13.25	17.88	0.81	4.0	2	Slightly silty, cloudy brown water
02-165	10.00	10.08	19.94	1.66	6.5	2	Slightly silty, cloudy brown water
02-166	5.30	5.57	19.92	2.44	14.0	3	Silty, grayish-brown water
03-116	3.10	3.23	24.42	4.08	19.5	2	Silty/sandy, brown water
03-117	3.59	3.75	26.81	3.88	25.0	0	Silty/sand, brown water
03-118	3.62	3.76	27.67	4.02	16.5	3	Silty/sandy, brown water
04-111	1.71	1.79	27.54	4.81	11.5	2	Silty, brown water
04-112	4.70	4.72	27.56	3.82	11.0	3	Silty, brown water
04-113	3.48	3.55	27.52	4.01	8.5	2	Silty, gray/brown water
04-115	5.02	5.19	27.43	3.74	11.5	1	Silty, brown water
04-148	5.63	5.81	17.85	2.04	9.5	3	Silty, brown water
04-249	14.69	14.77	27.92	2.20	11.5	2	Slightly silty, cloudy brown water

01 - Southwest Landfill
02 - Fire Training Area 2
03 - Fire Training Area 1
04 - West Ramp

Table 3-2
(continued)

Well Number	Depth to Water: Inner Casing (ft)	Depth to Water: Outer Casing (ft)	Depth to Bottom of Well (ft)	Volume: in Well (gals)	Volume: Evacuated (gals)	Number of Times Well Bailed Dry	Notes
04-150	14.06	14.03	17.92	0.64	3.5	2	Heavily silty, dark brown water
04-251	20.52	20.60	30.90	1.73	11.0	2	Slightly silty, light brown water
04-152	7.94	8.05	19.87	1.99	9.75	3	Silty, rusty brown water
04-253	9.15	9.25	37.87	4.80	19.5	3	Silty, gray/brown water
04-154	4.58	4.64	15.91	1.89	18.5	3	Silty, brown water
04-255	5.33	5.37	35.75	5.08	25.0	2	Silty, brown water
05-105	3.75	3.79	26.79	3.85	14.5	2	Silty/sandy, brown water
05-107	5.53	5.62	27.34	3.64	10.5	2	Silty/sandy, gray water
05-130	4.88	5.07	12.29	1.24	49.0	3	Silty, gray water
05-231	34.5	34.54	36.00	0.25	0.25	3	Silty, gray water
05-233	9.60	9.70	38.35	4.8	25.0	3	Silty, gray water
05-132	4.71	4.83	18.86	2.41	15.0	3	Silty, gray/brown water
05-134	6.58	6.71	17.60	1.84	14.0	3	Silty, gray/brown water
05-235	5.98	6.06	32.07	4.36	19.0	2	Silty/sandy, brown water
05-167	9.33	10.13	19.89	1.76	9.0	2	Silty, brown water
06-108	6.23	6.33	26.14	3.32	16.0	3	Silty/sandy, gray water
06-109	2.44	2.56	27.29	4.15	15.5	3	Silty/sandy, gray water
06-110	4.91	5.00	27.99	3.85	20.0	0	Silty/sandy, gray water
06-144	5.45	5.78	19.85	2.40	17.0	2	Silty, brown water
06-245	7.66	7.75	37.46	4.97	27.0	4	Heavily silty, gray water
06-146	5.52	5.79	17.90	2.06	11.5	2	Slightly silty, light brown water
06-247	5.75	5.85	29.04	1.73	11.0	2	Very heavily silty, gray water
07-102	6.71	6.76	27.75	2.67	6.0	3	Silty, brown water

04 - West Ramp
05 - Tucker Creek Landfill
06 - Northwest Landfill
07 - East Ramp

Table 3-2
(continued)

Well Number	Depth to Water Inner Casing (ft)	Depth to Water Outer Casing (ft)	Depth to Bottom of Well (ft)	Volume in Well (gals)	Volume Evacuated (gals)	Number of Times Well Bailed Dry	Notes
07-103	4.54	4.66	24.91	3.40	6.5	5	Silty, gray/brown water
07-104	3.50	3.63	25.05	3.60	9.0	5	Silty/sandy, brown water
07-136	7.28	7.48	19.83	2.09	25.0	0	Silty, gray/brown water
07-237	8.64	8.66	40.92	5.39	23.5	3	Silty, gray/brown water
07-138	12.67	12.89	17.87	0.86	4.0	4	Slightly silty, light brown water
07-239	28.37	28.43	37.89	1.59	14.5	5	Heavily silty, dark gray water
07-140	7.92	8.13	17.87	1.66	8.0	4	Silty, light brown water
07-241	33.67	33.74	38.10	0.74	3.5	2	Slightly silty, brown water
07-142	4.66	4.89	17.92	2.20	23.5	3	Silty, light brown water
07-243	10.66	10.74	37.92	4.50	29.0	4	Very silty, gray water
08-126	12.69	12.76	22.88	1.70	7.5	2	Very silty, gray water
08-127	6.25	6.46	22.83	3.81	15.0	2	Very silty, gray water
08-128	12.91	12.98	19.87	1.16	6.5	2	Very silty, gray water
08-129	7.66	7.72	19.87	2.04	9.5	2	Very silty, gray water

07 - East Ramp
08 - Base Coal Storage Pile

Table 3-3

Soil Borings and Monitor Wells By Site, IRP Stage 2, Selfridge ANGB, MI

Site Number	Site Name	Boring Number	Well Number
01	Southwest Landfill (SWLF)		01-122*
			01-123*
			01-124*
			01-125*
			01-156
			01-257
			01-158
			01-259
			01-160
			01-261
			01-162
			01-163
02	Fire Training Area 2 (FTA-2)	02-422	02-164
		02-423	02-165
		02-424	02-166
03	Fire Training Area 1 (FTA-1)	03-418	03-116*
		03-419	03-117*
		03-420	03-118*
04	West Ramp (WRMP)	04-406	04-111*
		04-407	04-112*
		04-408	04-113*
		04-409	04-115*
		04-410	04-148
		04-411	04-249
		04-412	04-150
		04-413	04-251
		04-414	04-152
		04-415	04-253
			04-154
			04-255

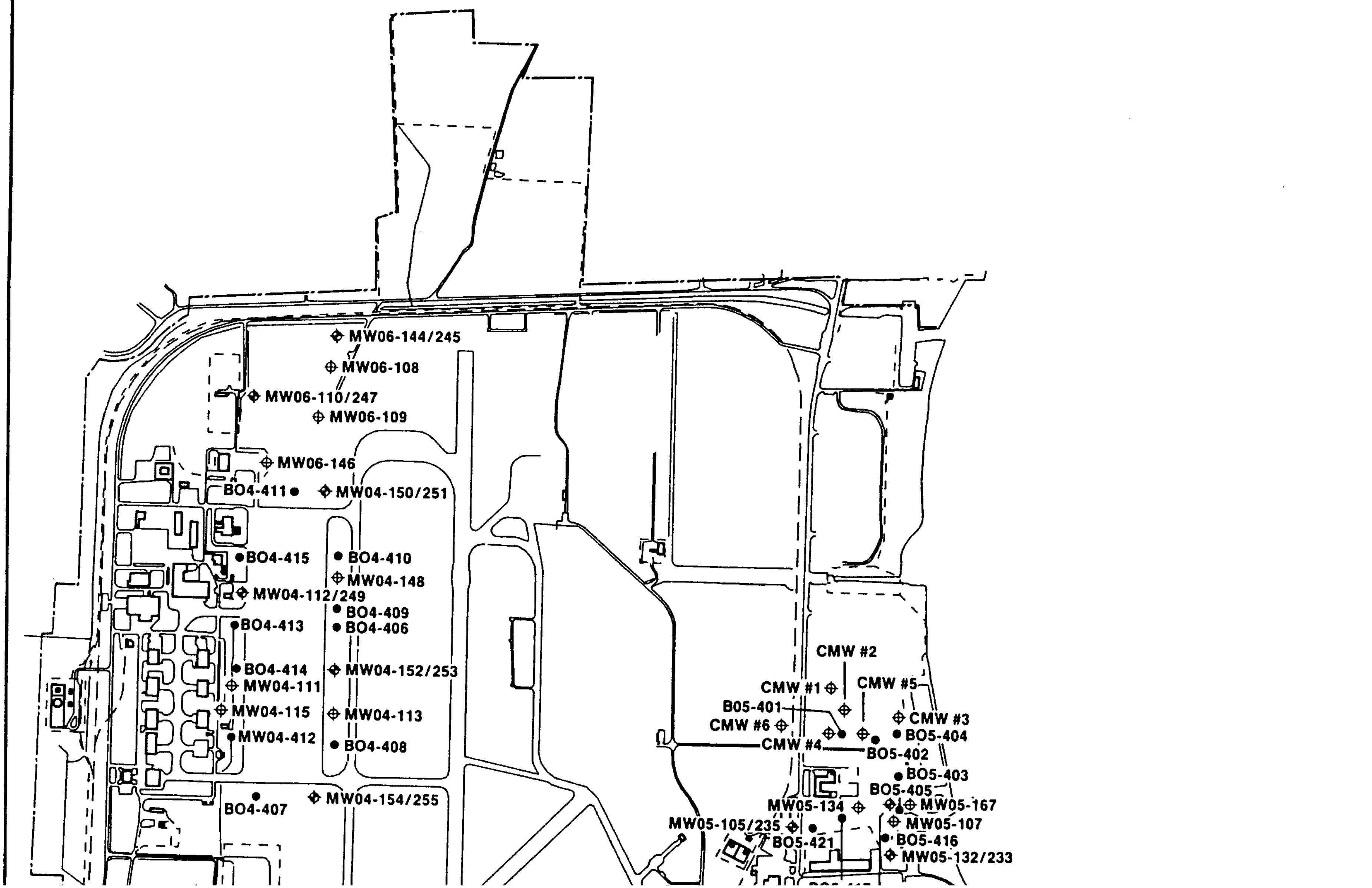
*Installed during Phase II Stage 1.

Table 3-3

Soil Borings and Monitor Wells By Site,
IRP Stage 2, Selfridge ANGB, MI

Site Number	Site Name	Boring Number	Well Number
01	Southwest Landfill (SWLF)		01-122*
			01-123*
			01-124*
			01-125*
			01-156
			01-257
			01-158
			01-259
			01-160
			01-261
			01-162
			01-163
02	Fire Training Area 2 (FTA-2)	02-422	02-164
		02-423	02-165
		02-424	02-166
03	Fire Training Area 1 (FTA-1)	03-418	03-116*
		03-419	03-117*
		03-420	03-118*
04	West Ramp (WRMP)	04-406	04-111*
		04-407	04-112*
		04-408	04-113*
		04-409	04-115*
		04-410	04-148
		04-411	04-249
		04-412	04-150
		04-413	04-251
		04-414	04-152
		04-415	04-253
			04-154
			04-255

*Installed during Phase II Stage 1.


MW06-144/245
MW06-108
MW06-110/247
MW06-109
MW06-146
BO4-411
MW04-150/251
BO4-415
BO4-410
MW04-148
MW04-112/249
BO4-409
BO4-406
BO4-413
BO4-414
MW04-111
MW04-152/253
MW04-115
MW04-113
MW04-412
BO4-408
BO4-407
MW04-154/255
CMW #2
CMW #1
CMW #5
B05-401
CMW #6
CMW #3
BO5-404
CMW #4
BO5-402
BO5-403
BO5-405
MW05-134
MW05-167
MW05-107
MW05-105/235
BO5-421
BO5-416
MW05-132/233

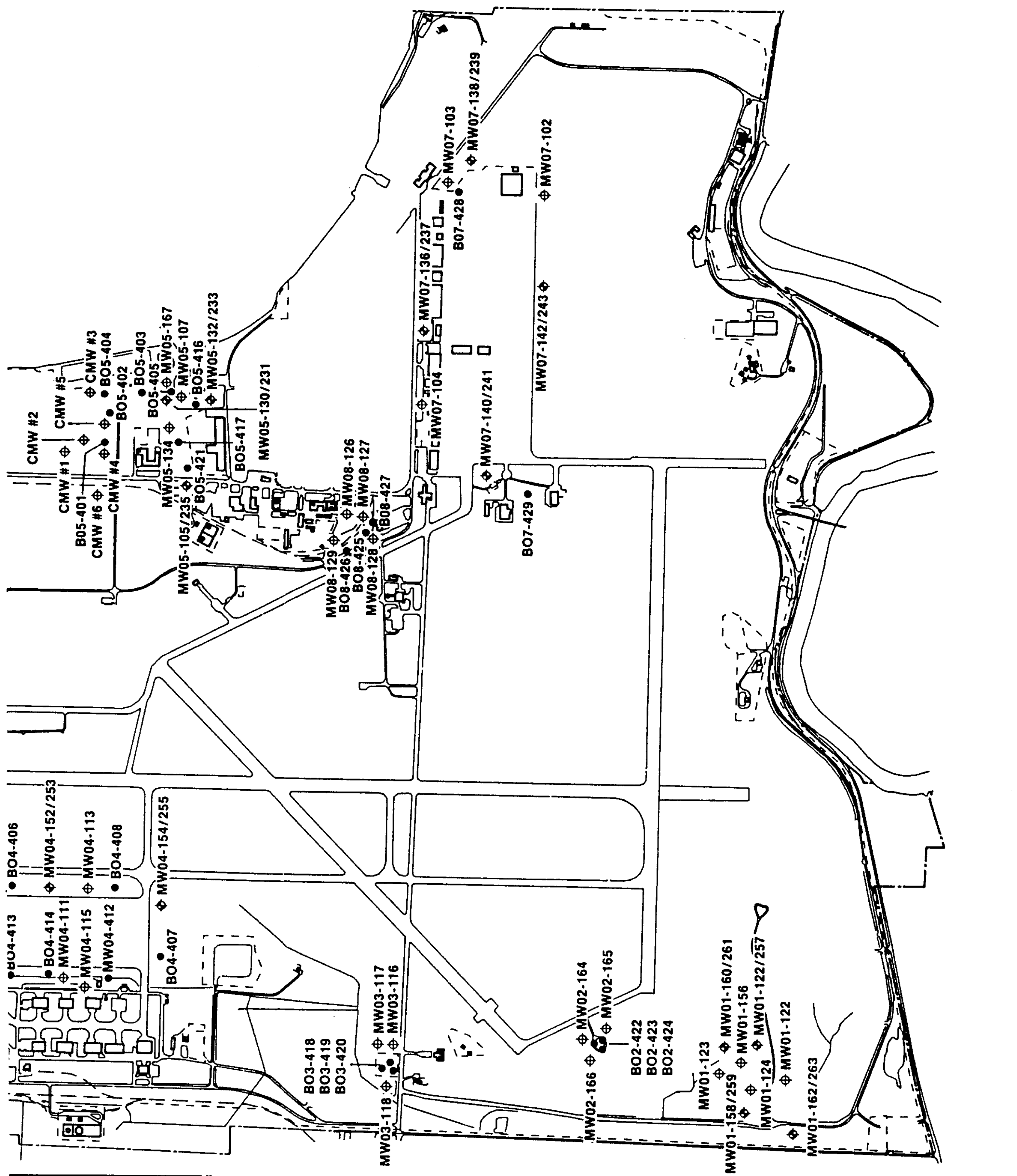


FIGURE 3-2 LO
AN
SF

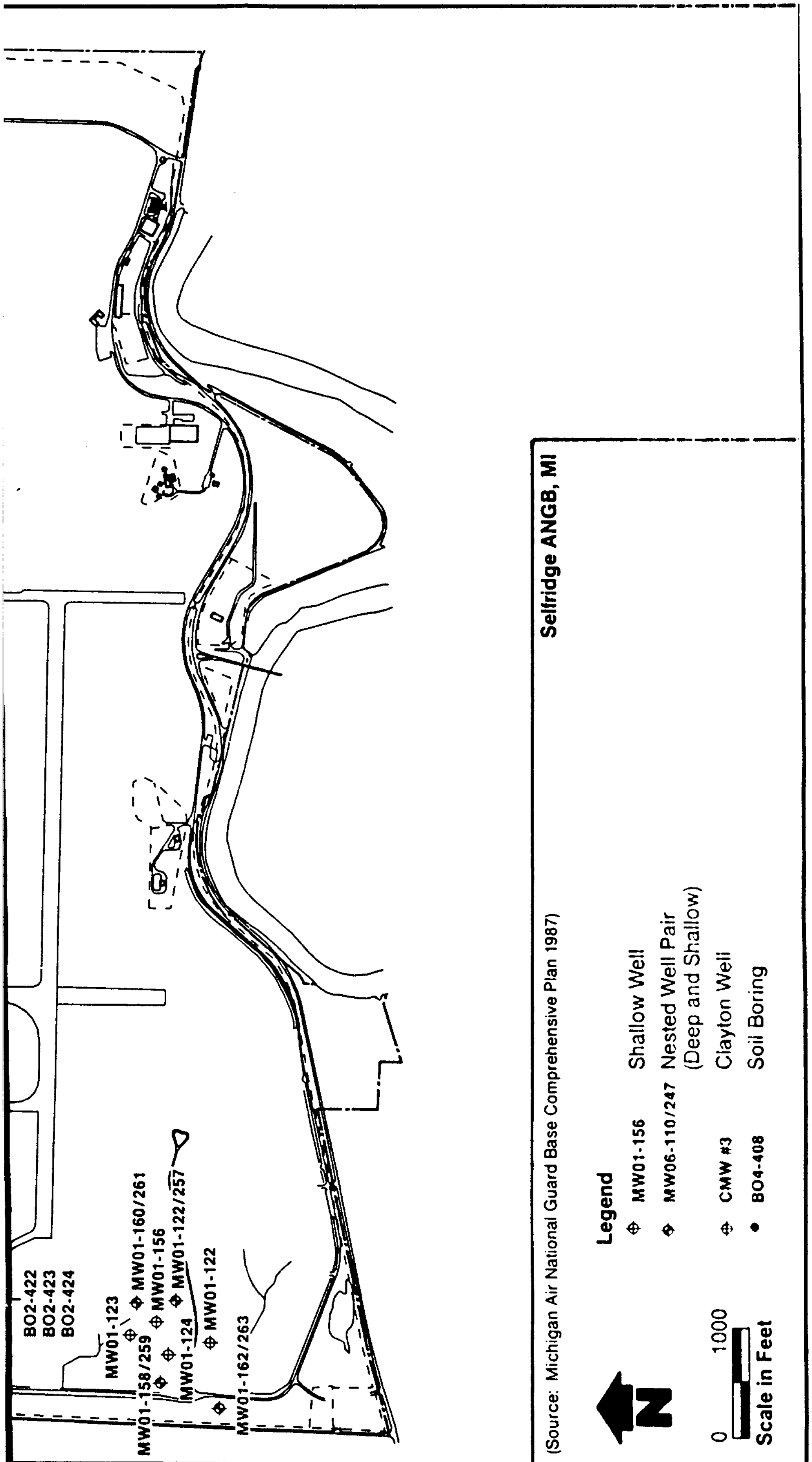


FIGURE 3-2 LOCATIONS OF SOIL BORINGS AND MONITOR WELLS AT SELFRIDGE ANGB

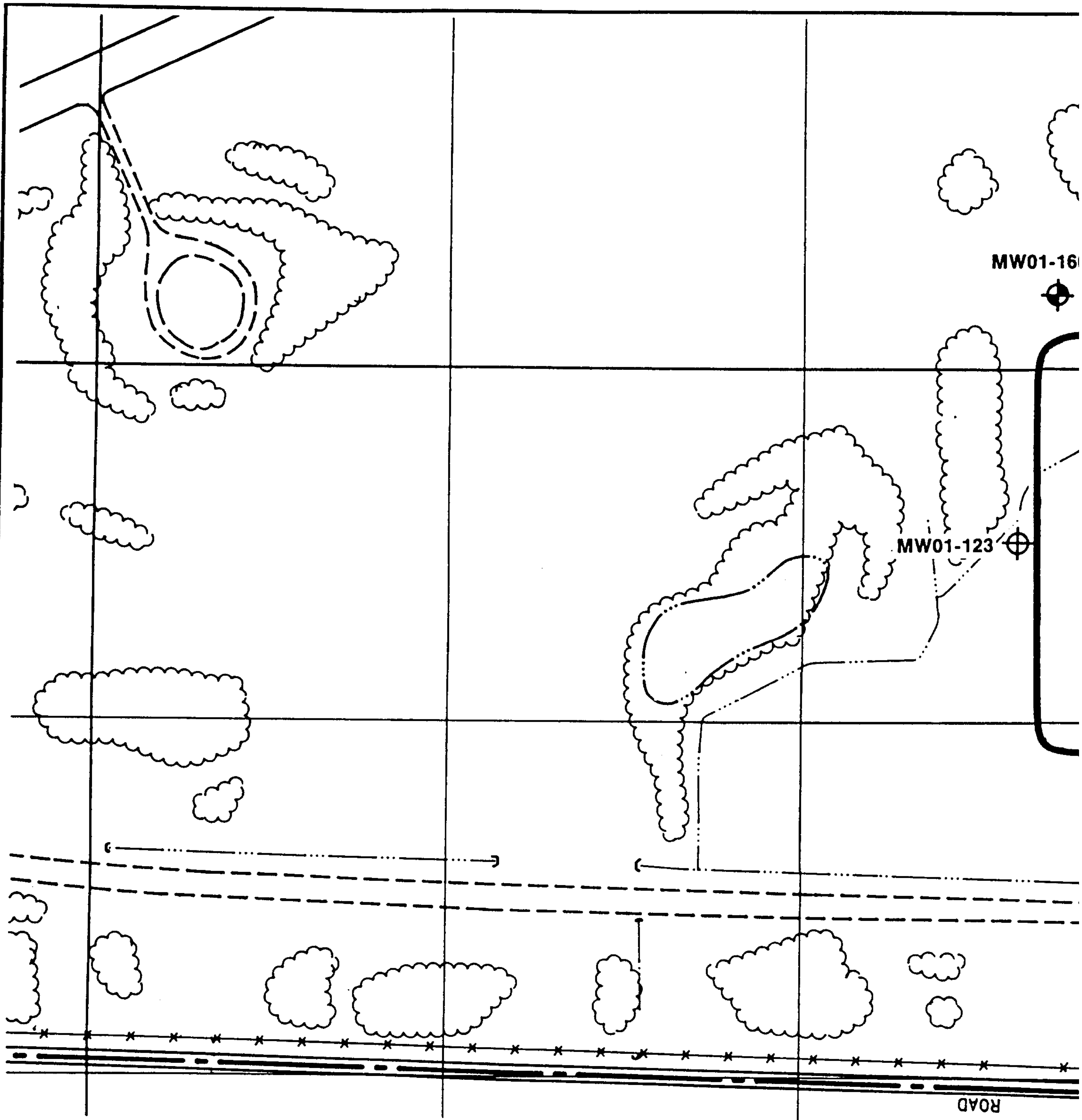
3.4.3.1 Site 1: Southwest Landfill (SWLF)

No soil borings were drilled at SWLF. However, soil samples were collected from four of the deep monitor well borings (01-257, 01-259, 01-261, and 01-263) as described in Subsection 3.6.1 of this report. Eight groundwater monitor wells were installed at SWLF at the locations shown in Figure 3-3. Well specifications for SWLF are summarized in Table 3-4. A deep well was paired with an adjacent shallow well at three locations to form well nests. An additional well nest was formed by the installation of a deep well with a Stage 1 well. A single shallow well was also installed at the site.

The purpose of the Stage 2 wells was to further identify the nature, extent, and magnitude of contamination at the site. This was accomplished by installing well nests southwest of the landfill, near the northeastern corner of the site, and along its western border. The single shallow well was installed to examine groundwater characteristics within the landfill interior. The Stage 2 wells expand the Stage 1 groundwater monitor network at the site from the 4 existing perimeter wells to a total of 12 wells. Groundwater sampling of these wells is described in Subsection 3.6.2 of this report.

The first well nest, shallow well 01-162 and its deep counterpart 01-263, was installed southwest of the landfill in an upgradient position. A second well nest, 01-158/259, was installed west of existing well 01-124 (W-24) in an area initially believed to be outside of the landfill's western boundary; however, the well nest was drilled through waste material. Well nest 01-160/261 was installed in a downgradient location at the northern end of the landfill's eastern perimeter. The original intended location for this well nest, at the eastern edge of the landfill's northern perimeter, proved to be inaccessible to a drill rig. Existing well 01-122 (W-22), which was shown on Phase II Stage 1 maps near the northeastern corner of the landfill, was discovered to be near the southeastern corner. The true location of 01-122 made installation of a fourth well nest planned for that location unnecessary. A single deep well, 01-257, was installed adjacent to 01-122, and a single shallow well, 01-156, was installed near the approximate center of the landfill.

The IRP Stage 2 deep monitor wells at SWLF were installed at depths ranging between 33 and 36 feet BLS. The 10-foot well screens were set in gray silty clay that contained a trace of sand. Screens for the shallow monitor wells were positioned at depths between 15 and 18 feet BLS. Monitor well 01-156 was screened in brown sandy silt to gray silty clay. The upper 5 feet of the screen for well 01-158 was set in landfill material, and the lower 5 feet was placed in underlying gray silty clay. The screens for wells 01-160 and 01-162 were placed within



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

0 100 200 400

Scale in Feet

Legend

Site Boundary

MW01-158/259 Nested Well Pair (Deep and Shallow)

MW01-156 Shallow Well

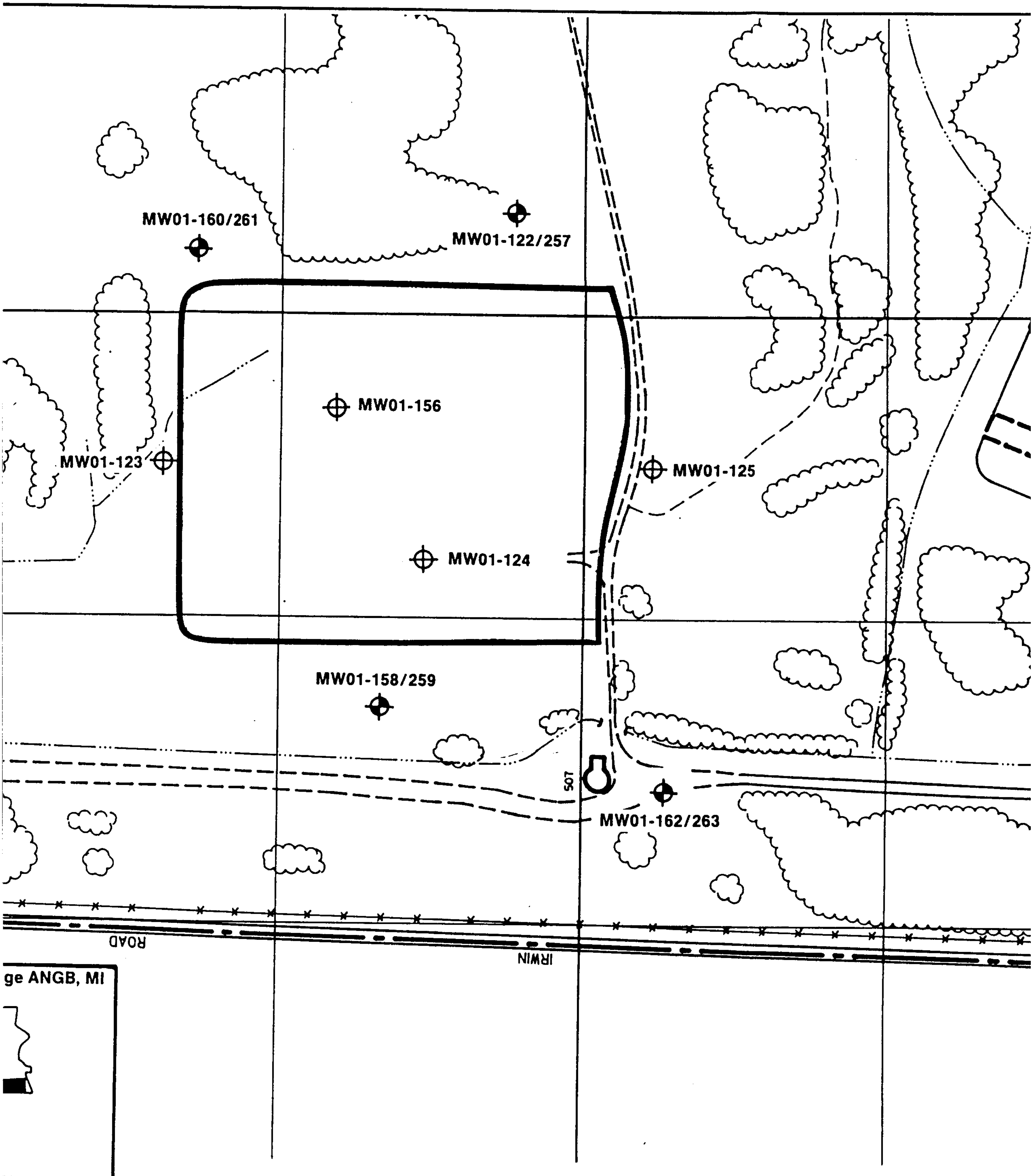


FIGURE 3-3 SOUT
(SWL

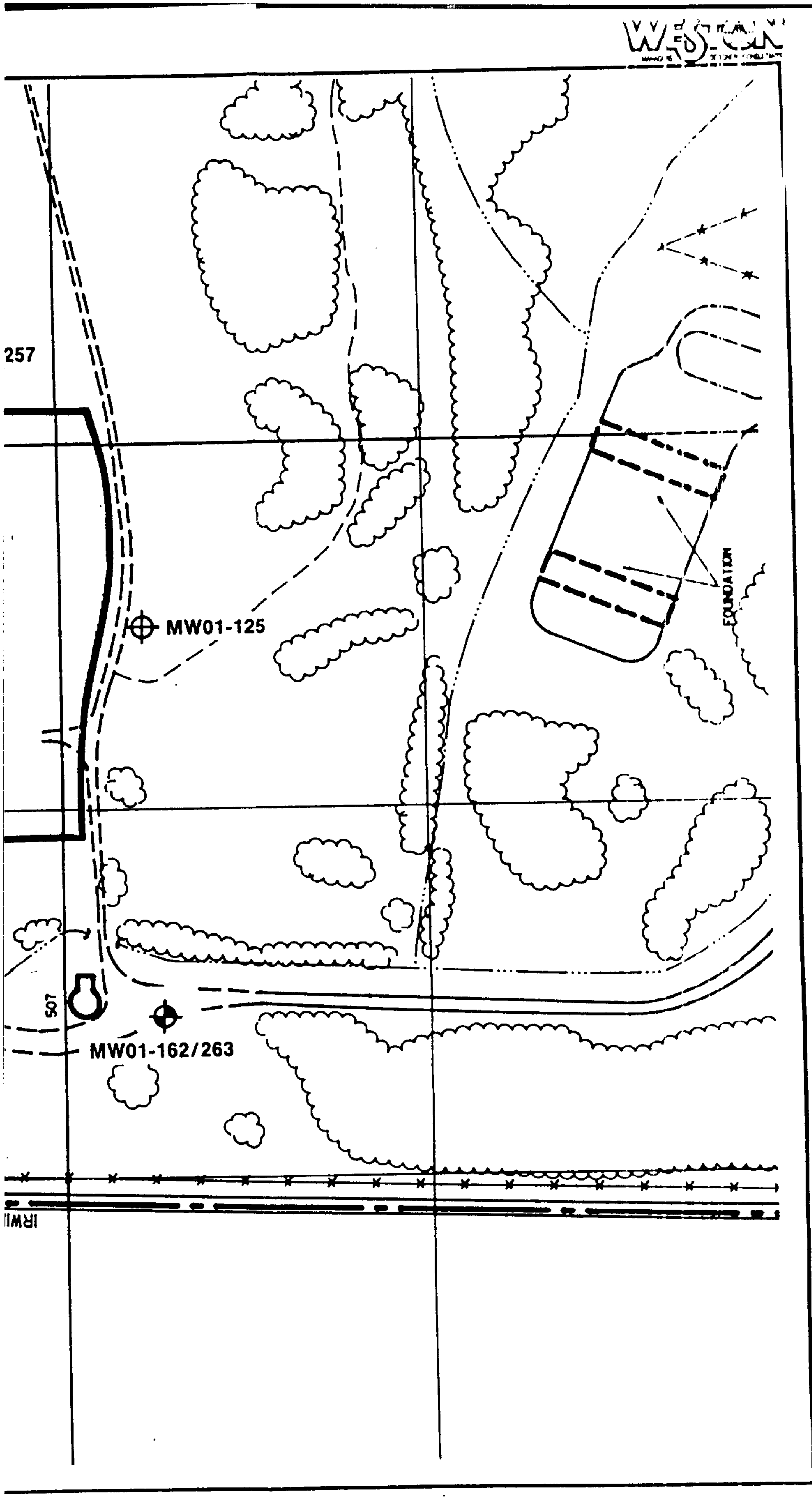
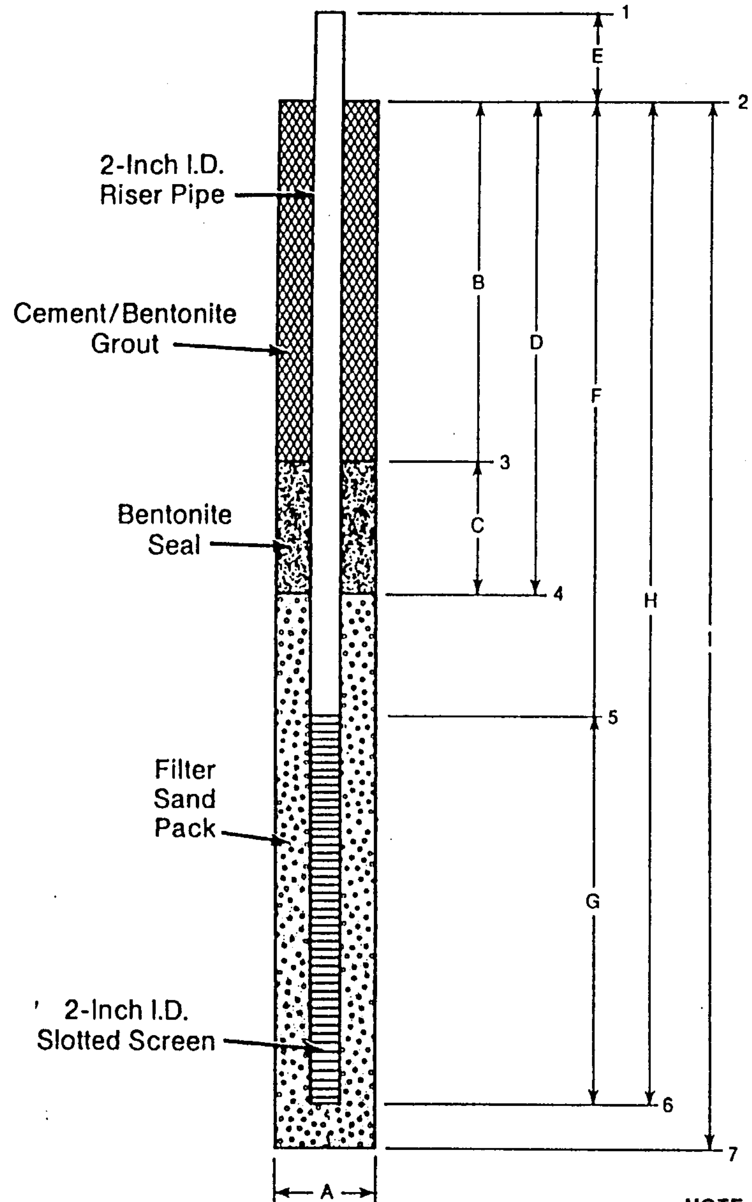


FIGURE 3-3 SOUTHWEST LANDFILL (SWLF) SITE MAP



Well Number		01-156	01-158	01-160	01-162
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	2	2	2.16	1.5
Thickness of Bentonite Seal	C	2.25	1	2.51	2
Depth of Seal	D	4.25	3	4.67	3.5
Riser Stick-Up	E	2.44	1.87	2.38	2.22
In-Ground Riser	F	7	5.3	7.67	5
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	17.3	15.6	17.97	15.3
Depth of Borehole	I	18.5	16	20	16.1
Top of Riser Elev.	1	584.71	586.31	583.67	585.26
Ground Surface Elev.	2	582.27	584.44	581.29	583.04
Top of Seal Elev.	3	580.27	582.44	579.13	581.54
Bottom of Seal Elev.	4	578.02	581.44	576.62	579.54
Top of Screen Elev.	5	575.27	579.14	573.62	578.04
Bottom of Screen Elev.	6	564.97	568.84	563.32	567.74
Bottom of Borehole Elev.	7	563.77	568.44	561.29	566.94

Well Number		01-257	01-259	01-261	01-263
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	20.5	19	17.12	19.5
Thickness of Bentonite Seal	C	2	2.92	2.3	2.17
Depth of Seal	D	22.5	21.92	19.42	21.67
Riser Stick-Up	E	2.43	1.65	1.88	2.03
In-Ground Riser	F	25.3	25.58	23.3	25
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	35.6	35.88	33.6	35.3
Depth of Borehole	I	36	36	35	36
Top of Riser Elev.	1	583.46	586.09	583.17	585.07
Ground Surface Elev.	2	581.03	584.44	581.29	583.04
Top of Seal Elev.	3	560.53	565.44	564.17	563.54
Bottom of Seal Elev.	4	558.53	562.52	561.87	561.37
Top of Screen Elev.	5	555.73	558.86	557.99	558.04
Bottom of Screen Elev.	6	545.43	548.56	547.69	547.74
Bottom of Borehole Elev.	7	545.03	548.44	546.29	547.04

NOTE: All measurements in feet except borehole diameter. Elevations in feet above mean sea level.

TABLE 3-4 SWLF MONITOR WELL SPECIFICATIONS, SELFRIDGE ANGB

an interlayered sequence of silty clay and clayey silt that contained minor amounts of sand. The monitor wells were screened in fine-grained soils because there are no significant, widespread coarse-grained deposits in the subsurface at this site. During drilling of the monitor well borings the top of the saturated zone was encountered at a depth of 1 to 14 feet BLS.

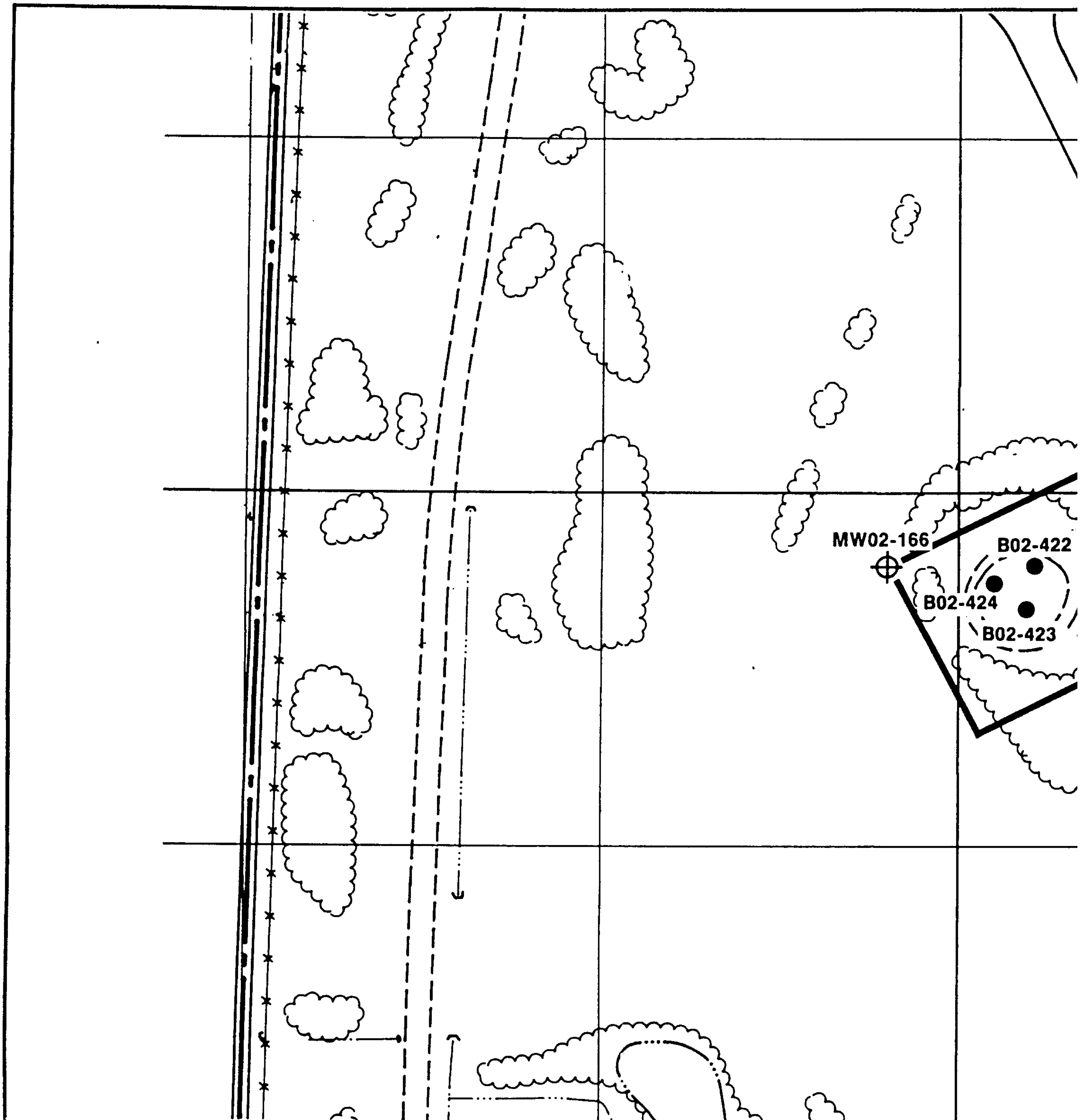
3.4.3.2 Site 2: Fire Training Area 2 (FTA-2)

The IRP Stage 2 drilling program at FTA-2 consisted of drilling three soil borings and replacing three groundwater monitor wells installed during the Stage 1 investigation. Locations are shown in Figure 3-4, with monitor well specifications presented in Table 3-5.

The purpose of the soil borings was to further define the soil stratigraphy and contaminant conditions beneath the burn pit area and to obtain representative soil samples. The soil sampling is described in Subsection 3.6.1 of this report. The replacement wells restored the site monitor network established during the Stage 1 investigation. Installation of the replacement wells was necessitated by heat damage to two of the Stage 1 wells during fire training exercises and by physical damage to the third, apparently the result of being struck by a vehicle. Sampling of the monitor wells is described in Subsection 3.6.2 of this report.

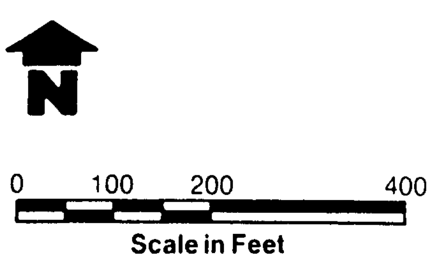
Abandonment and replacement of existing groundwater monitor well 02-120 (W-20) at FTA-2 were included in the Stage 2 Scope of Work. Abandonment and replacement of existing wells 02-119 (W-19) and 02-121 (W-21) were included in approved modifications to the SOW. Abandonment of the three damaged Stage 1 groundwater monitor wells was accomplished according to Michigan DNR regulations by pulling the entire well from the ground and grouting the hole to the surface.

The three replacement wells at FTA-2 are arranged in the same general configuration as the Stage 1 wells, relative to the center of the burn pit, but are located further from the pit in more remote and protected positions (see Figure 3-4). Well 02-164, the replacement for 02-120 (W-20), was installed in a downgradient position northeast of the burn pit and west of the access road entering the site. The location of 02-164 was shifted farther northeast than originally intended in order for it to be downgradient of an area containing waste fuel and stained vegetation discovered in the wooded area immediately northeast of the site. Well 02-165, the replacement for 02-121 (W-21), was established east of the burn pit at the edge of the parking area in a downgradient location. Well 02-166, the replacement for 02-119 (W-19), was established northwest of the burn pit in an upgradient location.



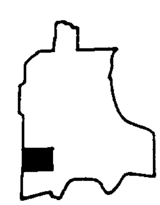
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

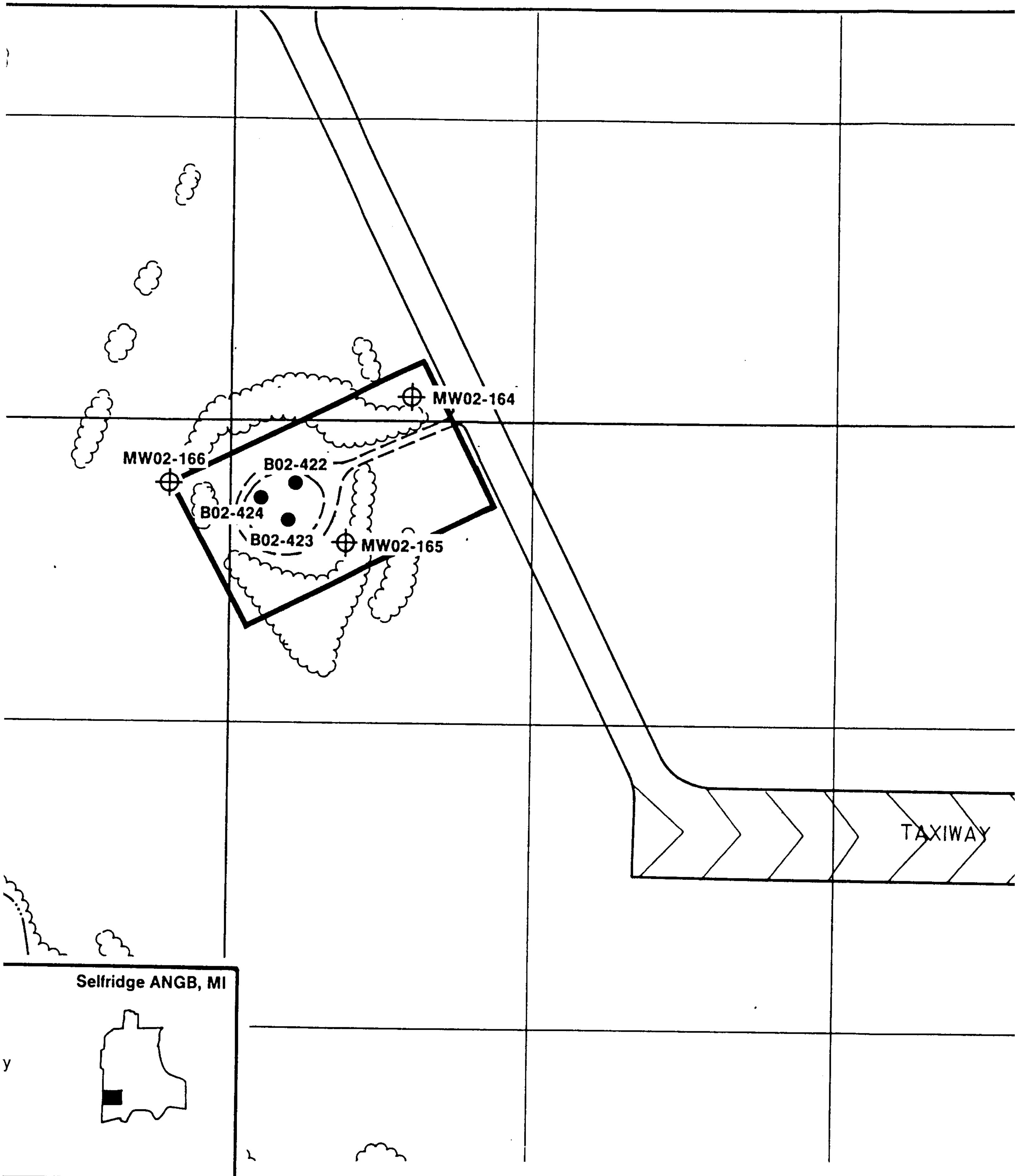
Selfridge ANGB, MI



Legend

	Site Boundary
MW02-166	Shallow Well
B02-422	Soil Boring




MW02-164
MW02-166
B02-422
B02-424
B02-423
MW02-165
TAXIWAY
Selfridge ANGB, MI
y

FIG

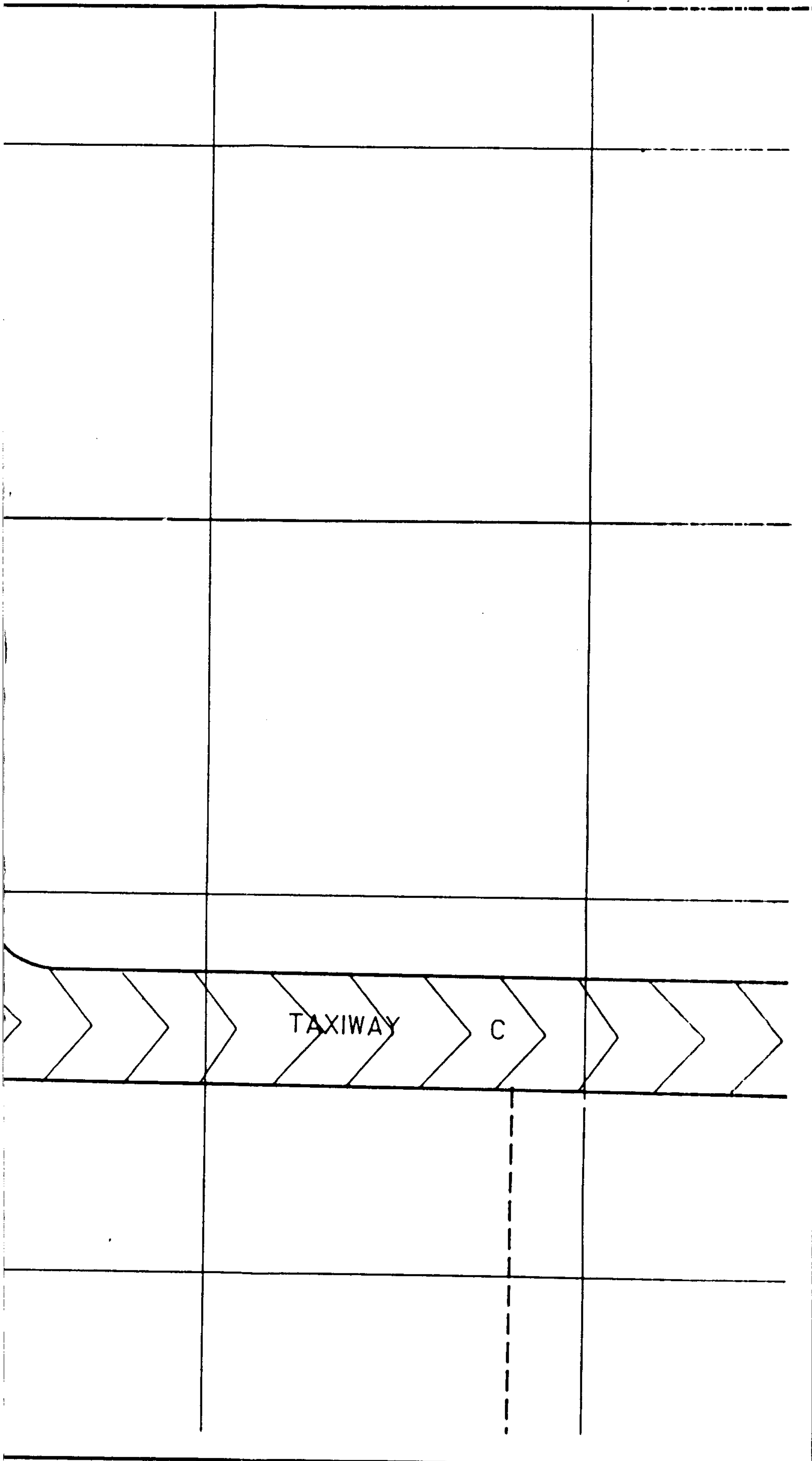
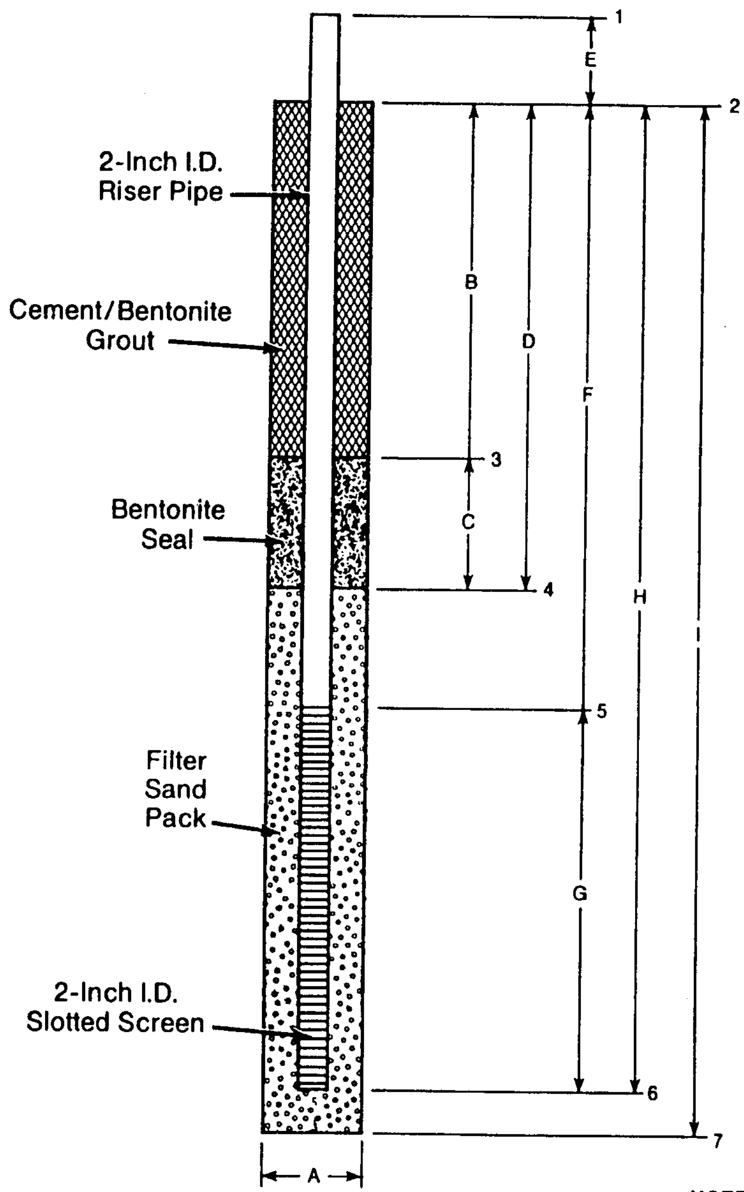


FIGURE 3-4 FIRE TRAINING AREA-2 (FTA-2) SITE MAP



Well Number		02-164	02-165	02-166
Borehole Diameter (inches)	A	8	8	8
Depth of Concrete	B	0.5	3	2.83
Thickness of Bentonite Seal	C	2	2	2
Depth of Seal	D	2.5	5	4.83
Riser Stick-Up	E	2.1	1.61	1.64
In-Ground Riser	F	5	6.64	6.64
Screen Length	G	10.3	10.3	10.3
Depth of Screen	H	15.3	16.94	16.94
Depth of Borehole	I	18	17.5	17.5
Top of Riser Elev.	1	580.42	581.55	581.89
Ground Surface Elev.	2	578.32	579.94	580.25
Top of Seal Elev.	3	577.82	576.94	577.42
Bottom of Seal Elev.	4	575.82	574.94	575.42
Top of Screen Elev.	5	573.32	573.3	573.61
Bottom of Screen Elev.	6	563.02	563	563.31
Bottom of Borehole Elev.	7	560.32	562.44	562.75

NOTE: All measurements in feet except borehole diameter. Elevations in feet above mean sea level.

TABLE 3-5 FTA-2 MONITOR WELL SPECIFICATIONS, SELFRIDGE, ANGB

The replacement wells were installed to depths between 15 and 17 feet, with 10-foot screens, in contrast to the abandoned Stage 1 wells, which had been installed to a depth of 26 feet with 20-foot screens. The replacement wells were screened in brown clayey silt and silty clay and the underlying gray clay to silty clay. The monitor wells were screened in fine-grained soils because there are no significant, wide-spread coarse-grained deposits in the subsurface at this site.

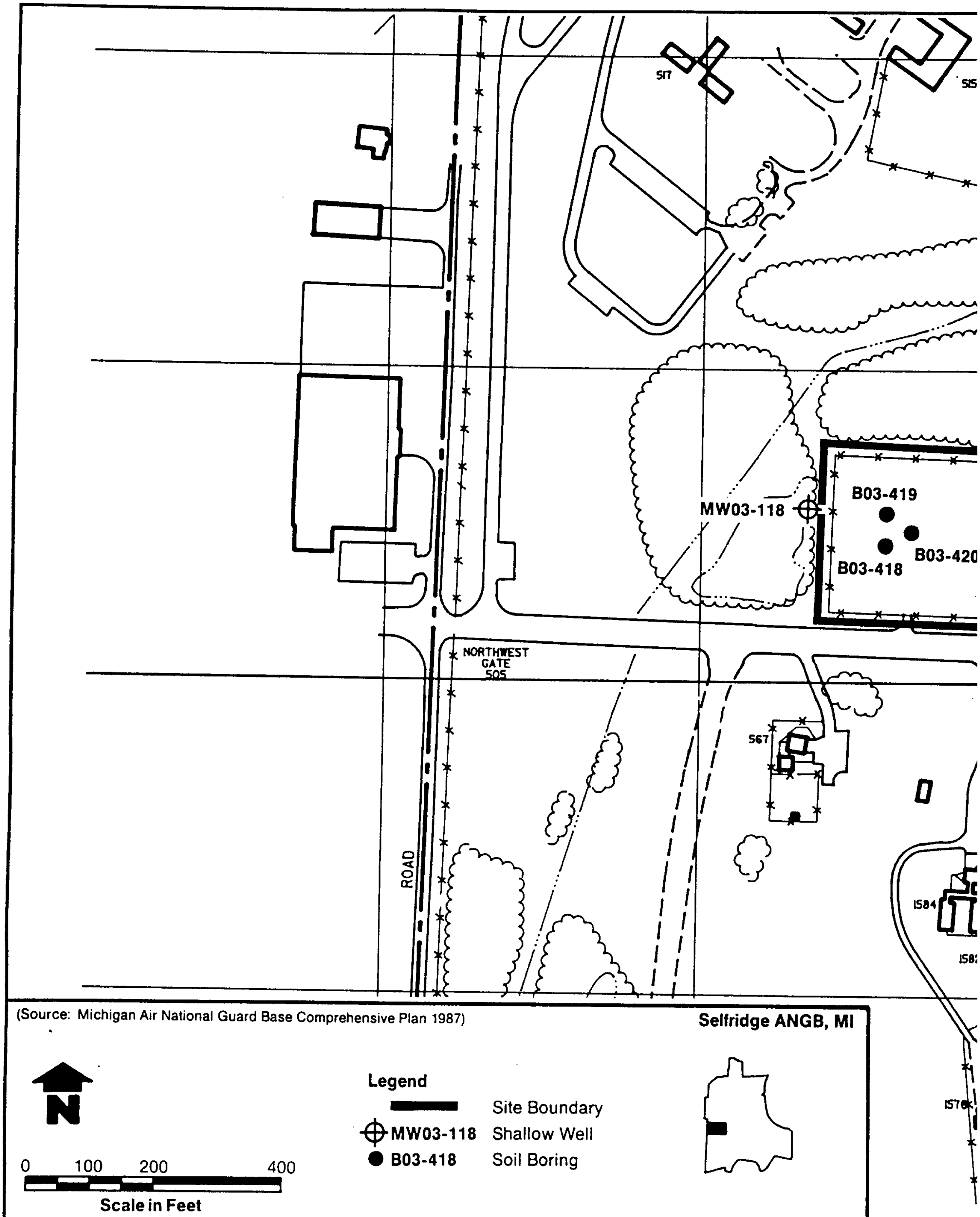
3.4.3.3 Site 3: Fire Training Area 1 (FTA-1)

The Stage 2 drilling program at FTA-1 consisted of drilling three soil borings to a depth of 30 feet in the former burn pit area. Locations are shown in Figure 3-5. The purpose of the soil borings was to further define the soil stratigraphy and contaminant conditions beneath the burn pit area and to obtain representative soil samples. Soil sampling of these borings is described in Subsection 3.6.1 of this report. No new groundwater monitor wells were installed at the site. The three existing wells at FTA-1, located on the site perimeter, were installed as part of the Stage 1 investigation. These wells were sampled for groundwater as described in Subsection 3.6.2 of this report. FTA-1 is now used by base security as the vehicle impoundment lot and is designated Storage Area One.

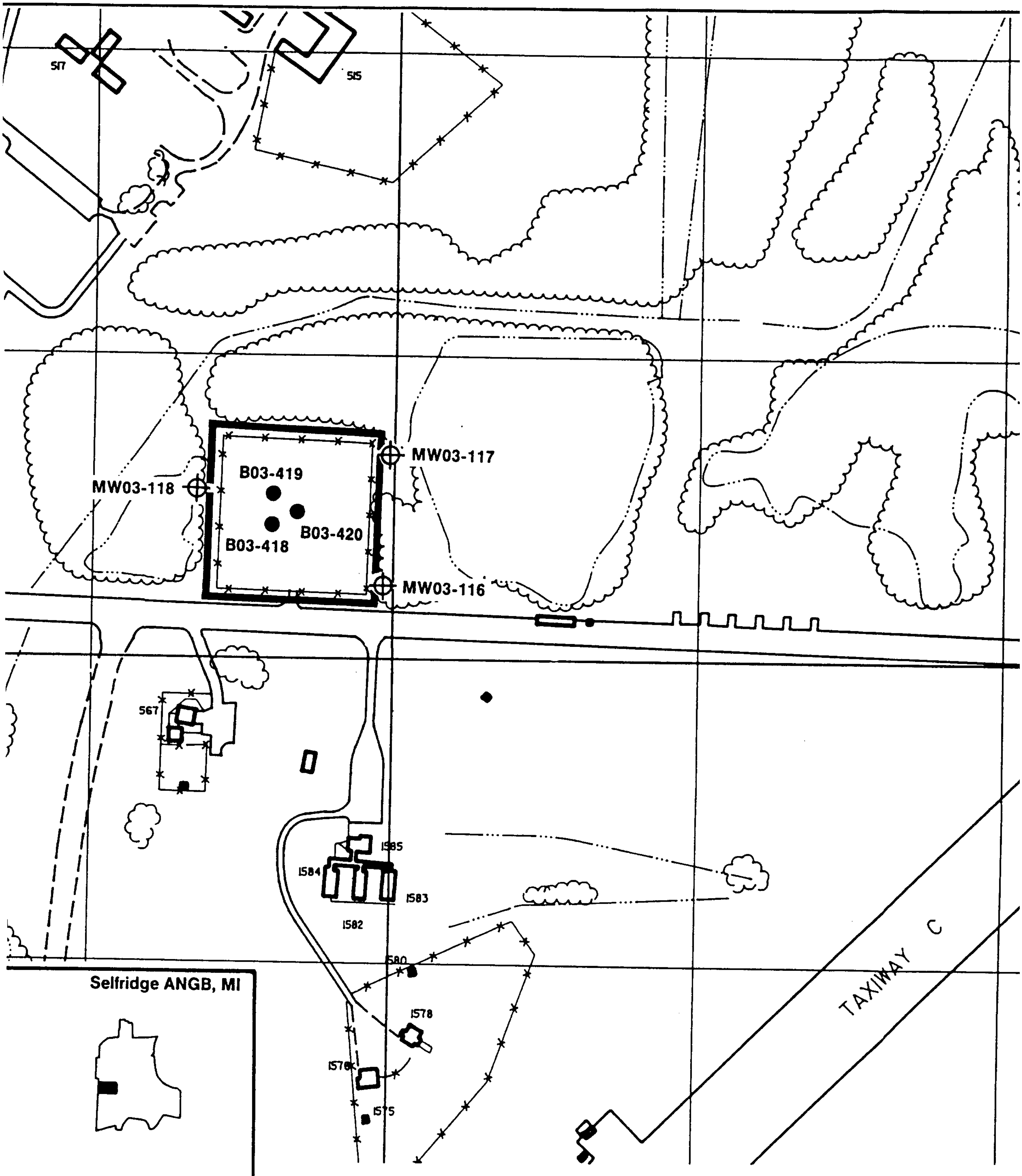
3.4.3.4 Site 4: West Ramp (WRMP)

Ten soil borings were drilled and eight groundwater monitor wells were installed at WRMP during the Stage 2 drilling program. Locations are shown in Figure 3-6. Four of the ten soil borings established at WRMP were drilled along the eastern perimeter of the site and four along the western perimeter. The two remaining soil borings were placed at the northern and southern ends of the ramp. Each of the 10 soil borings was established adjacent to a storm drain catch basin near the site perimeter to ascertain whether soil in these areas had been affected by possible contaminated stormwater runoff. Eight of the soil borings were drilled to 30 feet. Drilling was stopped at 29.5 feet in soil boring 04-406 and at 28.5 feet in soil boring 04-414 due to auger refusal. Soil sample collection procedures are described in Subsection 3.6.1 of this report.

Of the eight groundwater monitor wells, six were installed to form three well nests comprised of one shallow well and one deep well. The seventh well was paired with a previously installed Stage 1 IRP well. The eighth well, 04-148, replaced Stage 1 IRP well 04-114 (W-14) that had been destroyed. The purpose of the monitor well installations was to obtain representative groundwater quality and hydrogeologic data over the entire site by spacing the wells around the site perimeter. Monitor well specifications are listed in Table 3-6. Groundwater sampling procedures are described in Subsection 3.6.2 of this report.



517
515
MW03-118
B03-419
B03-420
B03-418
NORTHWEST
GATE
505
567
1584
1582
1576
ROAD
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0
100
200
400
Scale in Feet
Legend
Site Boundary
MW03-118 Shallow Well
B03-418 Soil Boring


517
515
MW03-117
MW03-118
B03-419
B03-420
B03-418
MW03-116
567
1585
1584
1583
1582
1580
1578
1576
1575
TAXIWAY C
Selfridge ANGB, MI

FIG

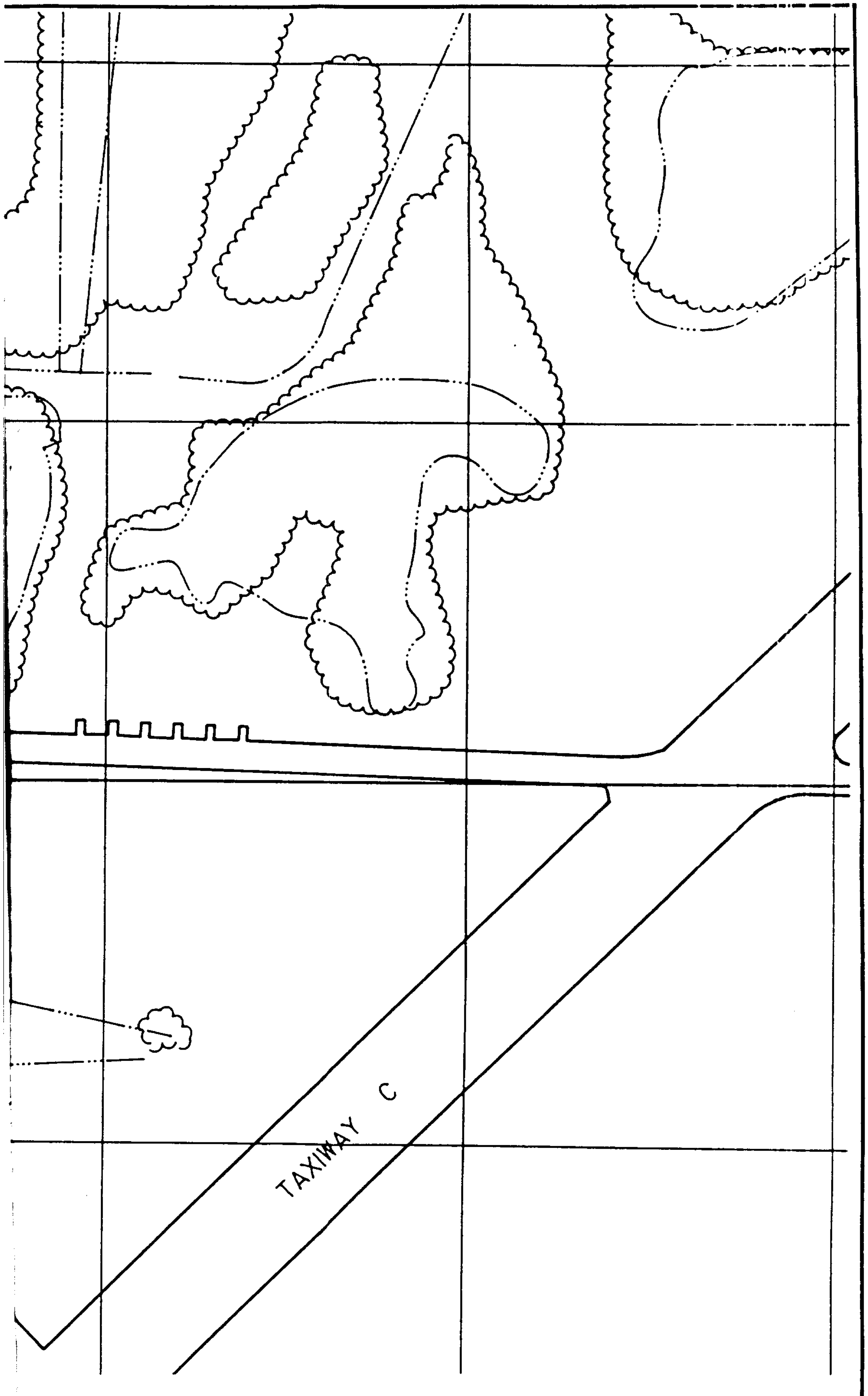
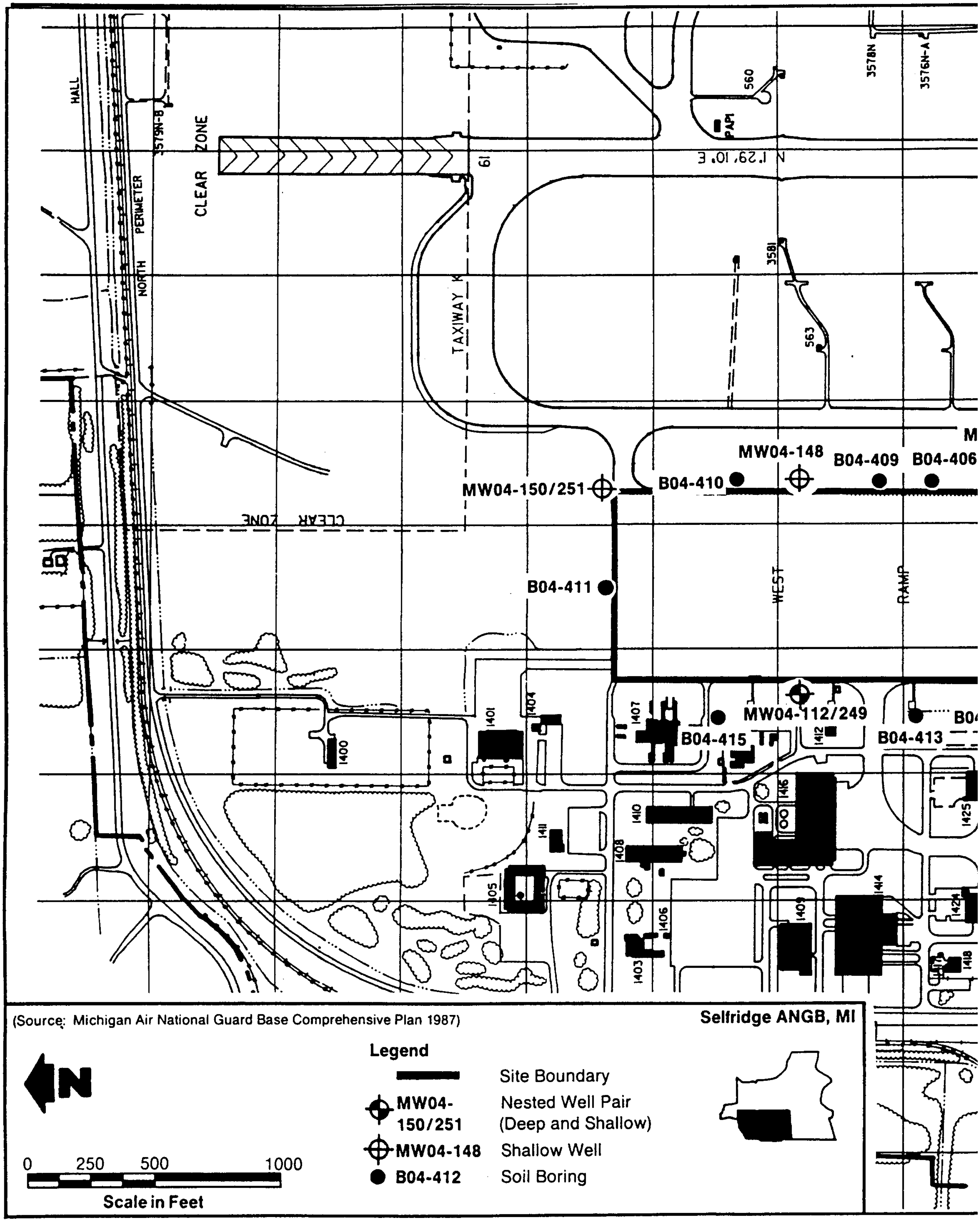
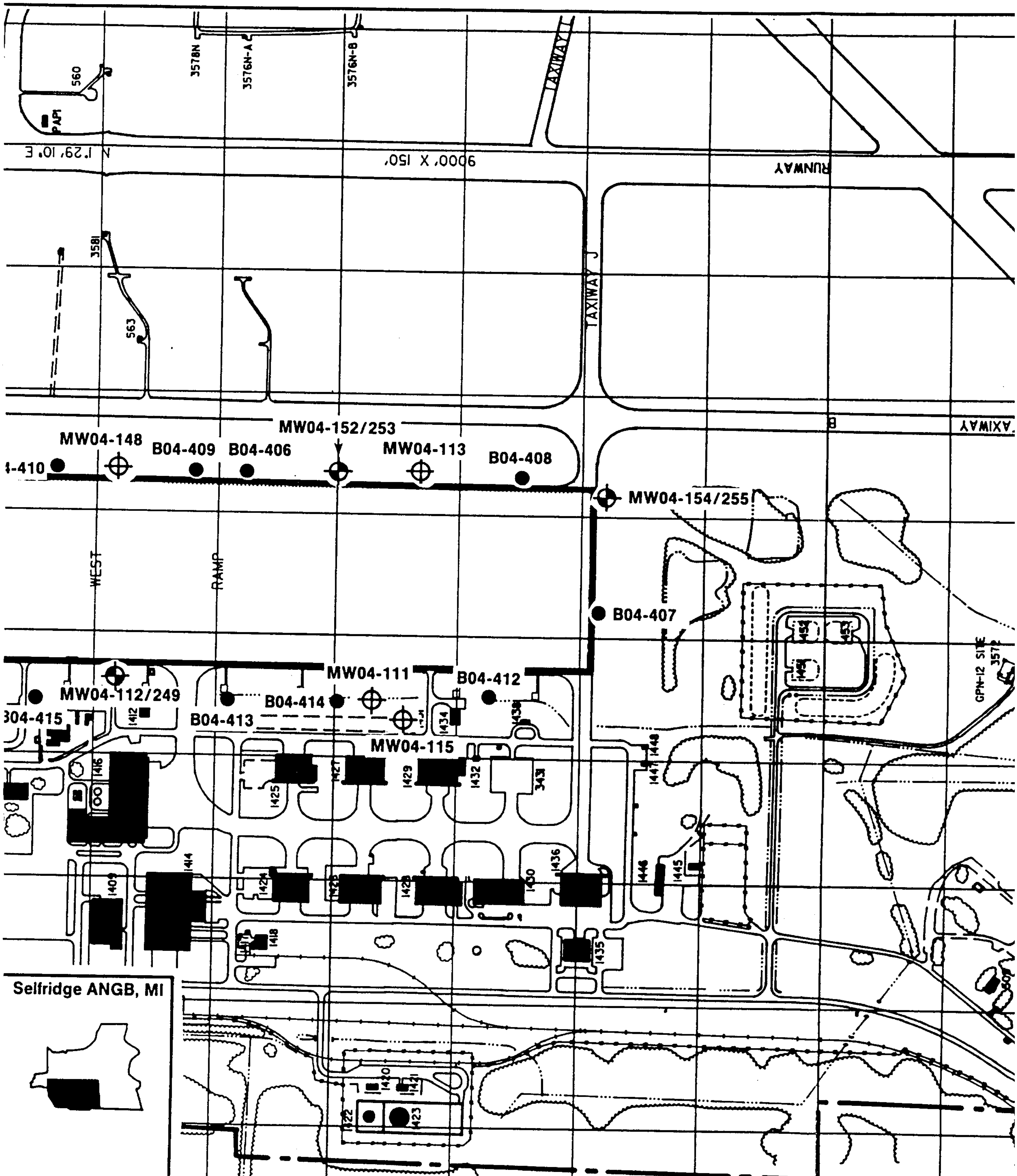


FIGURE 3-5 FIGURE TRAINING AREA 1
(FTA-1) SITE MAP



HALL
NORTH PERIMETER
3579N-B
CLEAR ZONE
TAXIWAY K
CLEAR ZONE
560
PAPI
3578N
3576N-A
N 1.29',10' E
3581
563
WEST RAMP
MW04-148
B04-409
B04-406
MW04-150/251
B04-410
B04-411
MW04-112/249
B04-415
B04-413
1400
1401
1404
1407
1412
1410
1411
1408
1405
1406
1403
1409
1414
1416
1418
1424
1425
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0 250 500 1000
Scale in Feet
Legend
Site Boundary
MW04-150/251 Nested Well Pair (Deep and Shallow)
MW04-148 Shallow Well
B04-412 Soil Boring



MW04-148
B04-409
B04-406
MW04-152/253
MW04-113
B04-408
MW04-154/255
B04-407
MW04-111
B04-412
MW04-112/249
B04-414
B04-413
MW04-115
WEST
RAMP
TAXIWAY J
RUNWAY
9000' X 150'
TAXIWAY
Selfridge ANGB, MI

FIGURE

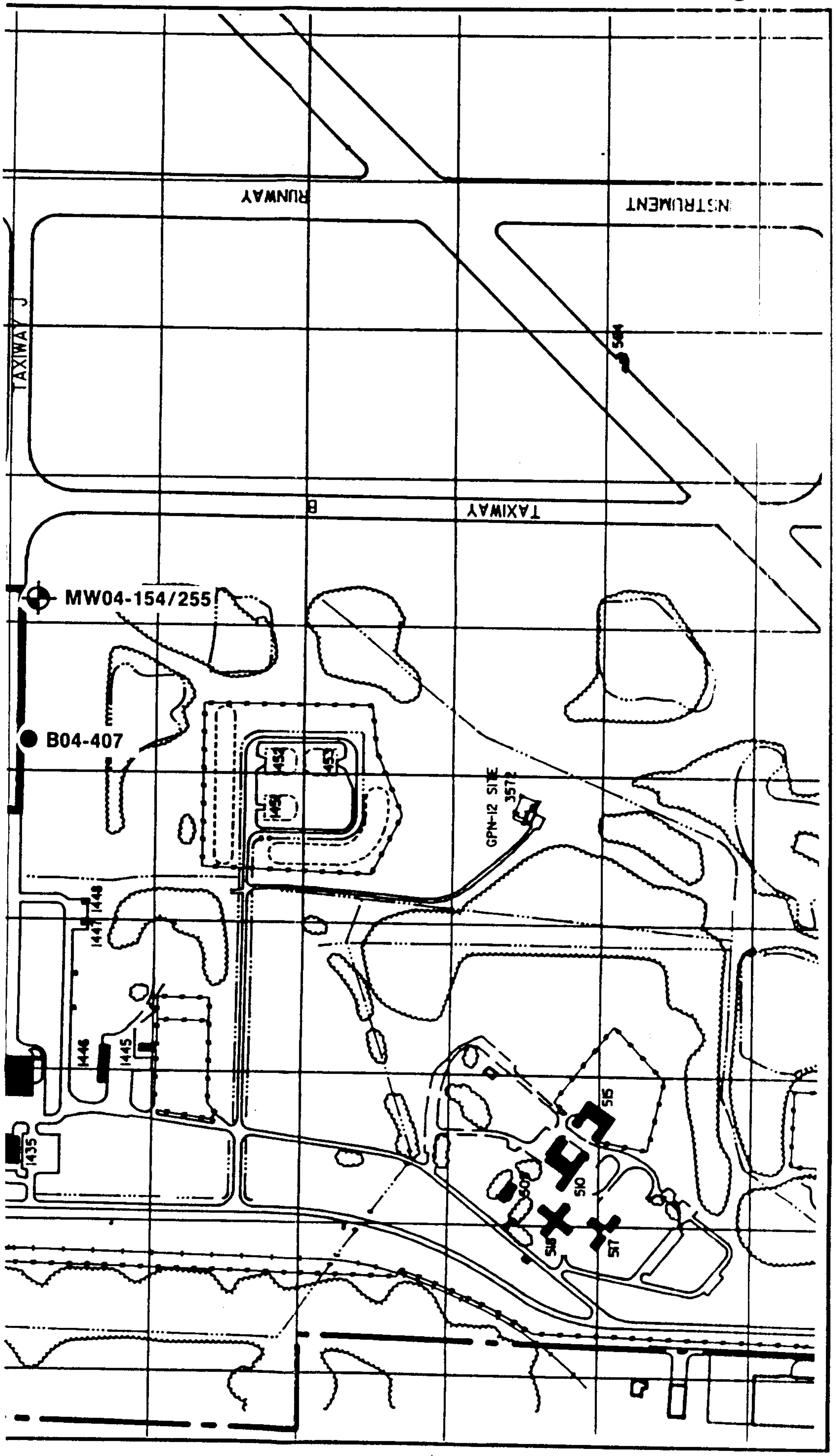
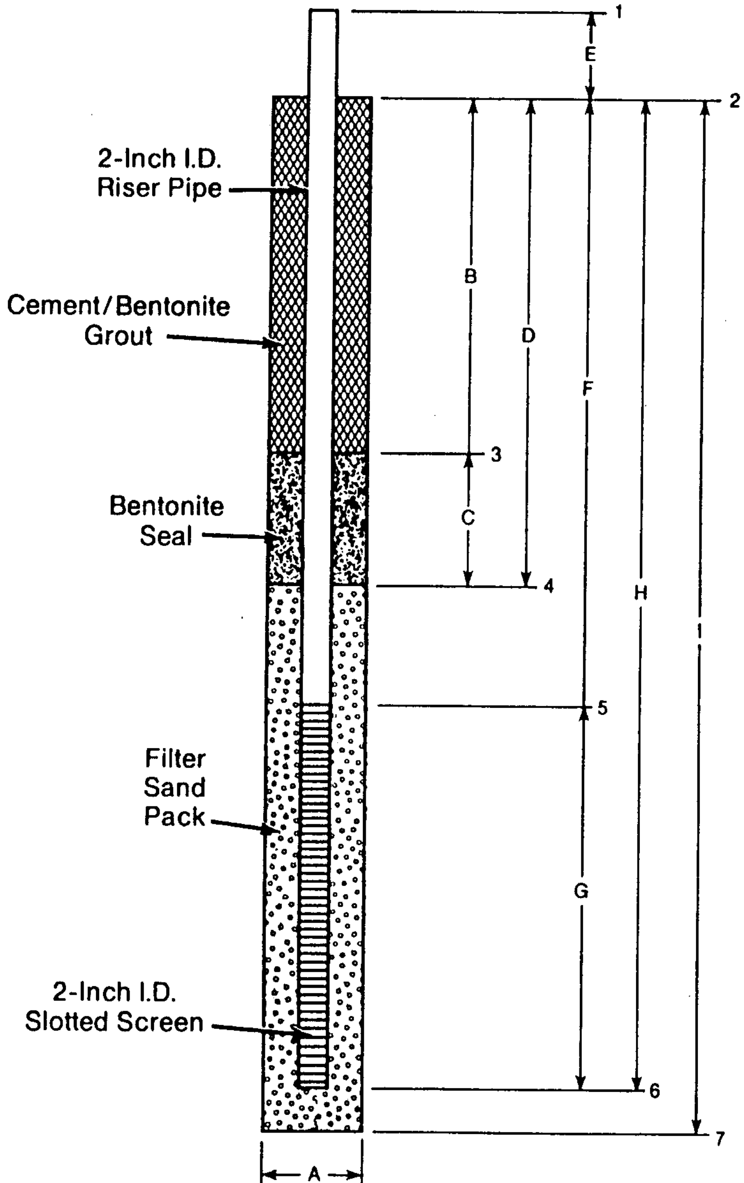


FIGURE 3-6 WEST RAMP (WRMP) SITE MAP



Well Number		04-148	04-150	04-152	04-154
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	0.67	2.9	1	1.8
Thickness of Bentonite Seal	C	1.83	1.1	2.3	1.2
Depth of Seal	D	2.5	4	3.3	3
Riser Stick-Up	E	2.28	2.56	4.32	1.86
In-Ground Riser	F	4.7	4.6	6.5	4.63
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	15	14.9	16.8	14.93
Depth of Borehole	I	16	15	18.25	15
Top of Riser Elev.	1	582.08	581.71	582.00	580.87
Ground Surface Elev.	2	579.8	579.15	577.68	579.01
Top of Seal Elev.	3	579.13	576.25	576.68	577.21
Bottom of Seal Elev.	4	577.3	575.15	574.38	576.01
Top of Screen Elev.	5	575.1	574.55	571.18	574.38
Bottom of Screen Elev.	6	564.8	564.25	560.88	564.08
Bottom of Borehole Elev.	7	563.8	564.15	559.43	564.01

Well Number		04-249	04-251	04-253	04-255
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	12.4	11.75	19	17
Thickness of Bentonite Seal	C	2	3.25	2	2
Depth of Seal	D	14.4	15	21	19
Riser Stick-Up	E	1.84	1.97	4.47	1.33
In-Ground Riser	F	17.33	18.17	24.64	23.5
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	26.64	28.47	34.94	33.8
Depth of Borehole	I	27.1	35	35	34
Top of Riser Elev.	1	581.54	581.12	582.15	580.34
Ground Surface Elev.	2	579.7	579.15	577.68	579.01
Top of Seal Elev.	3	567.3	567.4	558.68	562.01
Bottom of Seal Elev.	4	565.3	564.15	556.68	560.01
Top of Screen Elev.	5	563.36	560.98	553.04	555.51
Bottom of Screen Elev.	6	553.06	550.68	542.74	545.21
Bottom of Borehole Elev.	7	552.6	544.15	542.68	545.01

NOTE: All measurements in feet except borehole diameter. Elevations in feet above mean sea level.

TABLE 3-6 WRMP MONITOR WELL SPECIFICATIONS, SELFRIDGE ANGB

Seven Stage 2 wells were installed along the eastern perimeter of WRMP and one along the western perimeter. The eight Stage 2 wells join four existing Stage 1 wells at the site. Three of the Stage 1 wells are located along the eastern perimeter and one along the western perimeter of WRMP. A fifth Stage 1 well, W-14, sited at the northern end of the western perimeter, could not be located and is presumed to have been destroyed.

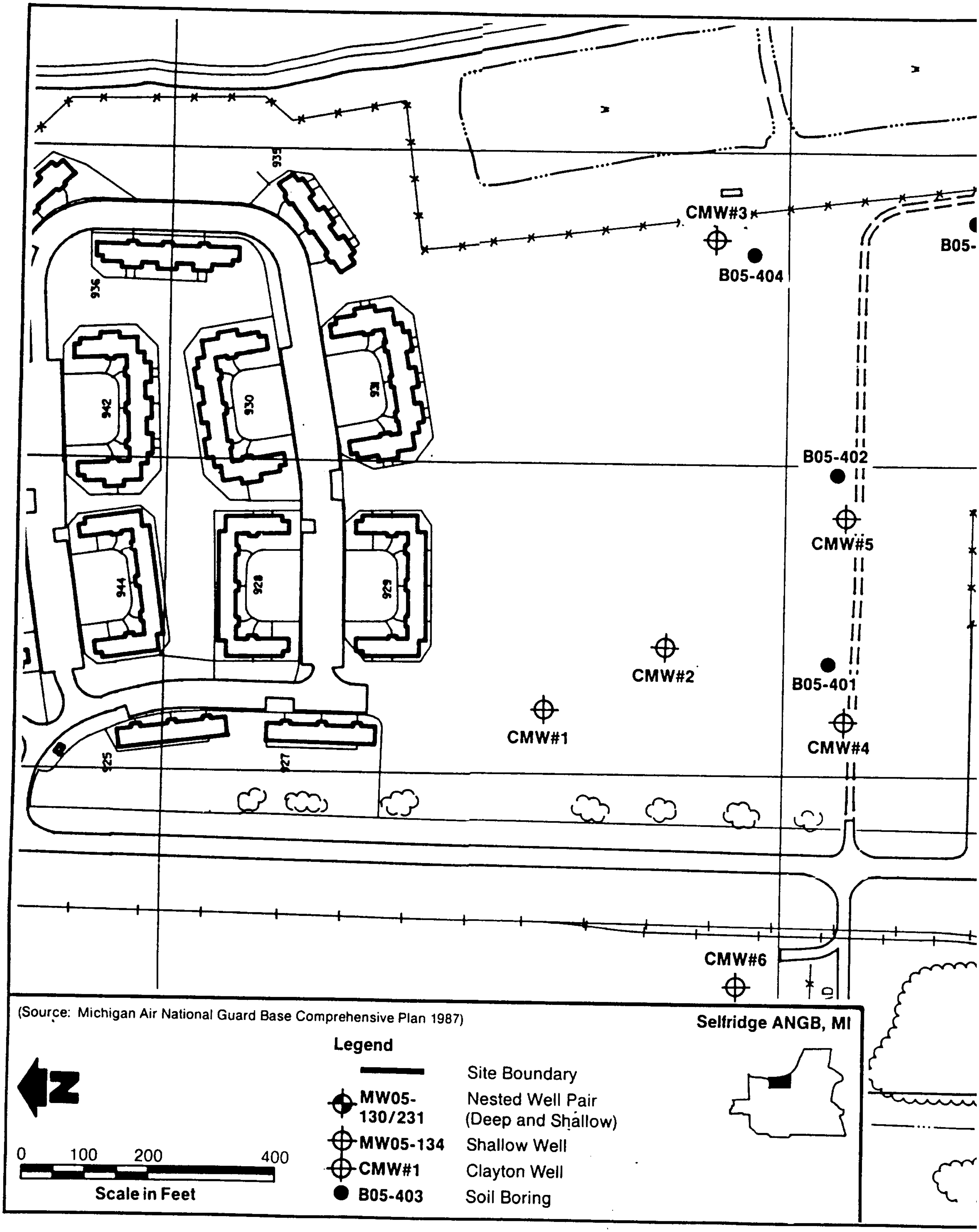
Well nest 04-154/255 was installed at the southeastern corner of WRMP, and well nest 04-150/251 was installed at the northeastern corner. Well nest 04-152/253 was established near the midpoint of the eastern perimeter. A single shallow well, 04-148, was installed approximately 20 feet south of the former location of W-14 on the eastern perimeter of the site. The deep well, 04-249, was established on the western perimeter beside Stage 1 IRP well 04-112. Placing 04-249 on the western perimeter achieved a better spatial distribution of the Stage 2 deep wells, with one deep well located on the upgradient (western) perimeter of the site and three deep wells on the downgradient (eastern) perimeter.

The Stage 2 deep wells at WRMP were installed at depths ranging from 27 to 35 feet. Screens (10-foot) were generally set in gray clay to silty clay and the underlying gray sandy clay to clayey sand. Shallow wells were established at depths ranging from 13 to 17 feet, with 10-foot screens set in brown to gray silt and clay and the underlying gray clay to silty clay. The monitor wells were screened in fine-grained soils because there are no significant, wide-spread coarse-grained deposits in the subsurface at this site. The top of the saturated zone was encountered between 8 and 11 feet during drilling of the well borings.

3.4.3.5 Site 5: Tucker Creek Landfill (TCLF)

Eight soil borings were drilled and six groundwater monitor wells installed at TCLF during the Stage 2 drilling program. Locations are shown in Figure 3-7 and monitor well specifications in Table 3-7. In addition, a destroyed Stage 1 well was replaced as part of the Stage 2 field effort at the site. The soil borings were drilled in the general vicinity of stormwater catch basins to determine whether soil in these areas had been affected by possible contaminated stormwater runoff. Soil sampling is described in Subsection 3.6.1 of this report. The groundwater monitor wells further define contaminants detected in the Stage 1 wells at the site. This definition was accomplished by installing these Stage 2 well nests on the eastern and northern perimeters of the landfill. Groundwater sampling is described in Subsection 3.6.2 of this report.

Three of the eight soil borings were located on the southern perimeter of the site, three on the northern perimeter, and two


935
936
942
930
931
944
928
929
925
927
CMW#3
B05-404
B05-
B05-402
CMW#5
CMW#2
B05-401
CMW#1
CMW#4
CMW#6
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW05-130/231 Nested Well Pair (Deep and Shallow)
MW05-134 Shallow Well
CMW#1 Clayton Well
B05-403 Soil Boring
N
0 100 200 400
Scale in Feet

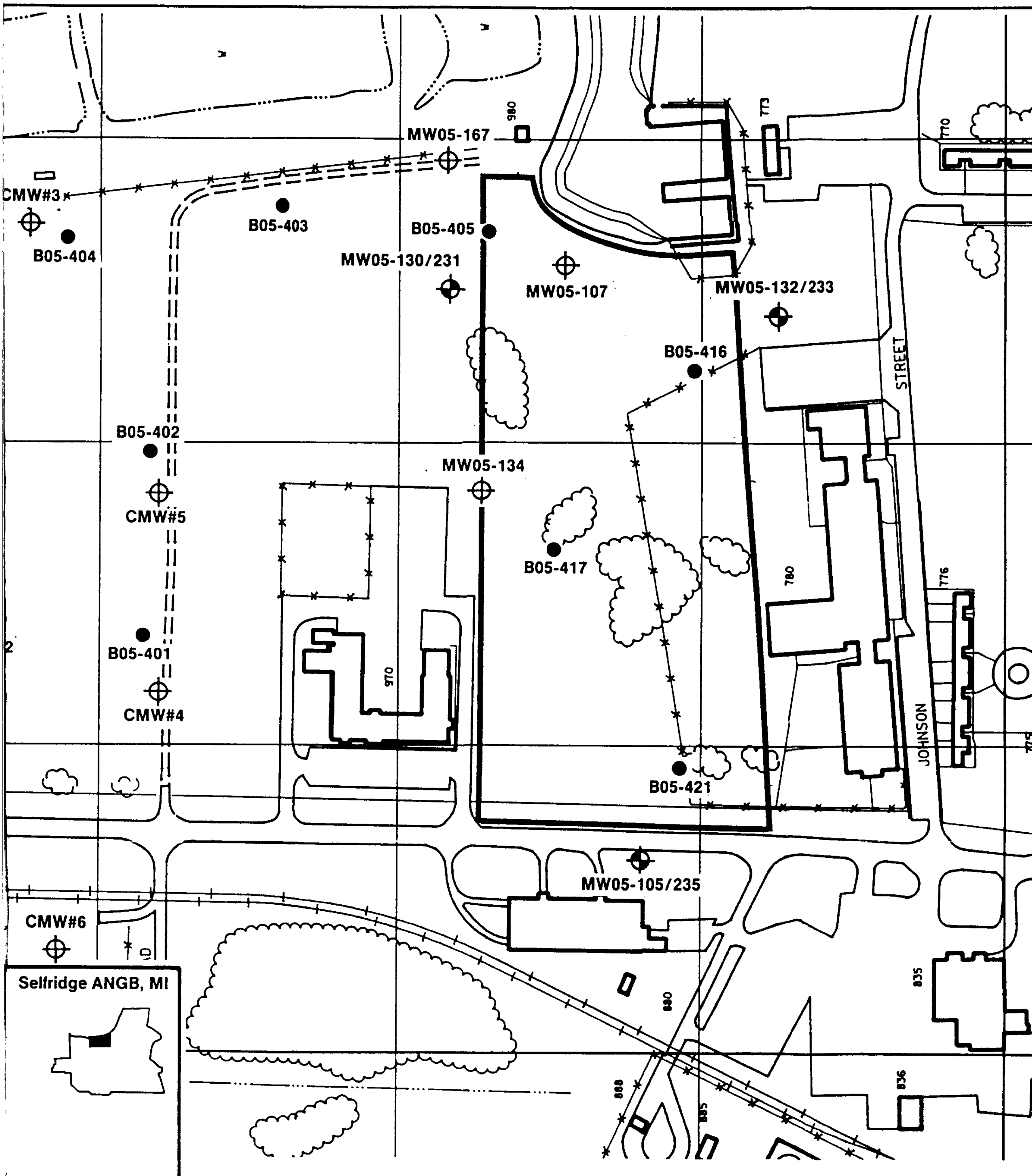

MW05-167
980
773
770
CMW#3
B05-403
B05-404
B05-405
MW05-130/231
MW05-107
MW05-132/233
B05-416
STREET
B05-402
MW05-134
CMW#5
B05-417
780
776
970
B05-401
CMW#4
JOHNSON
B05-421
MW05-105/235
CMW#6
Selfridge ANGB, MI
835
880
836
888
885

FIGURE 3-7 T
(T

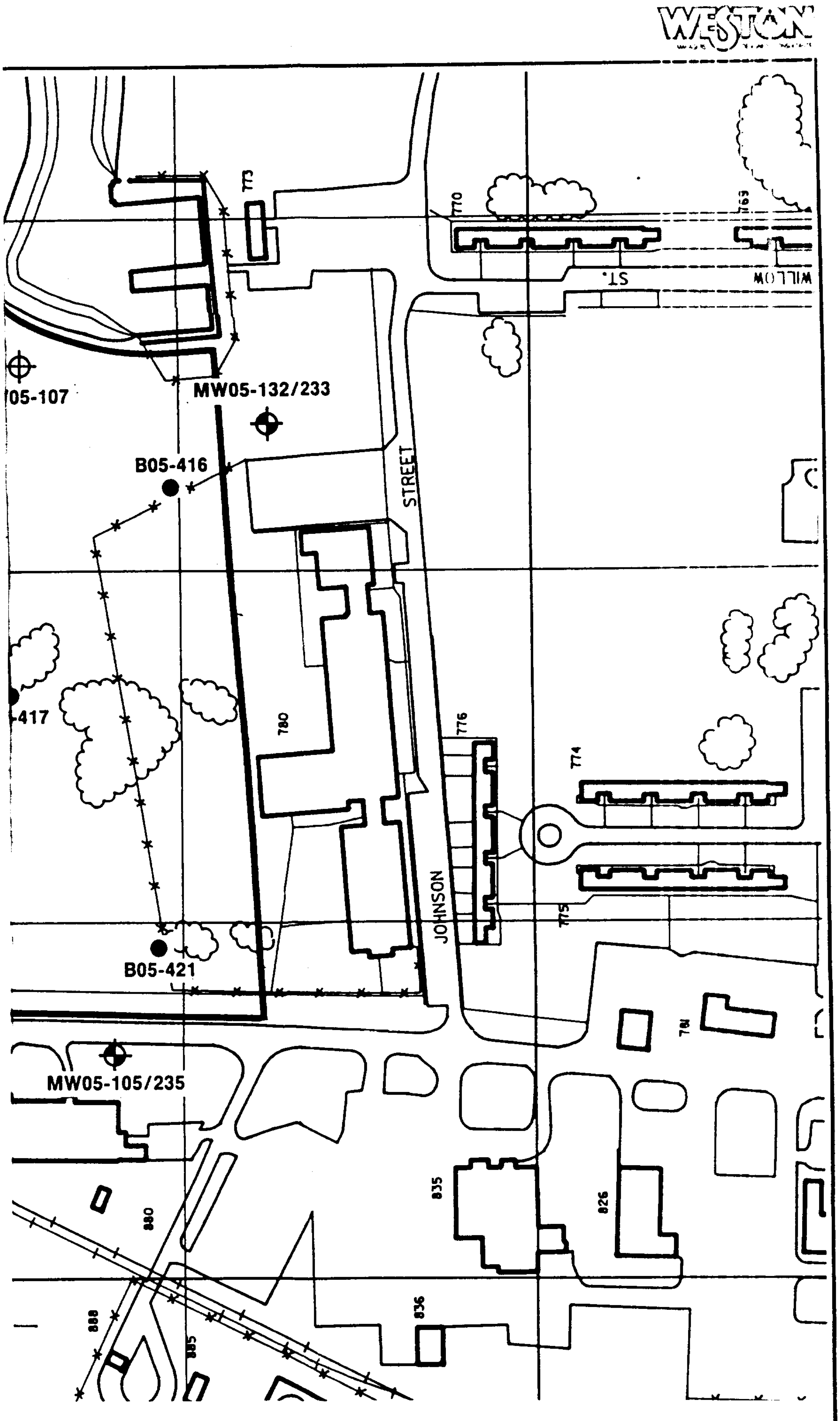
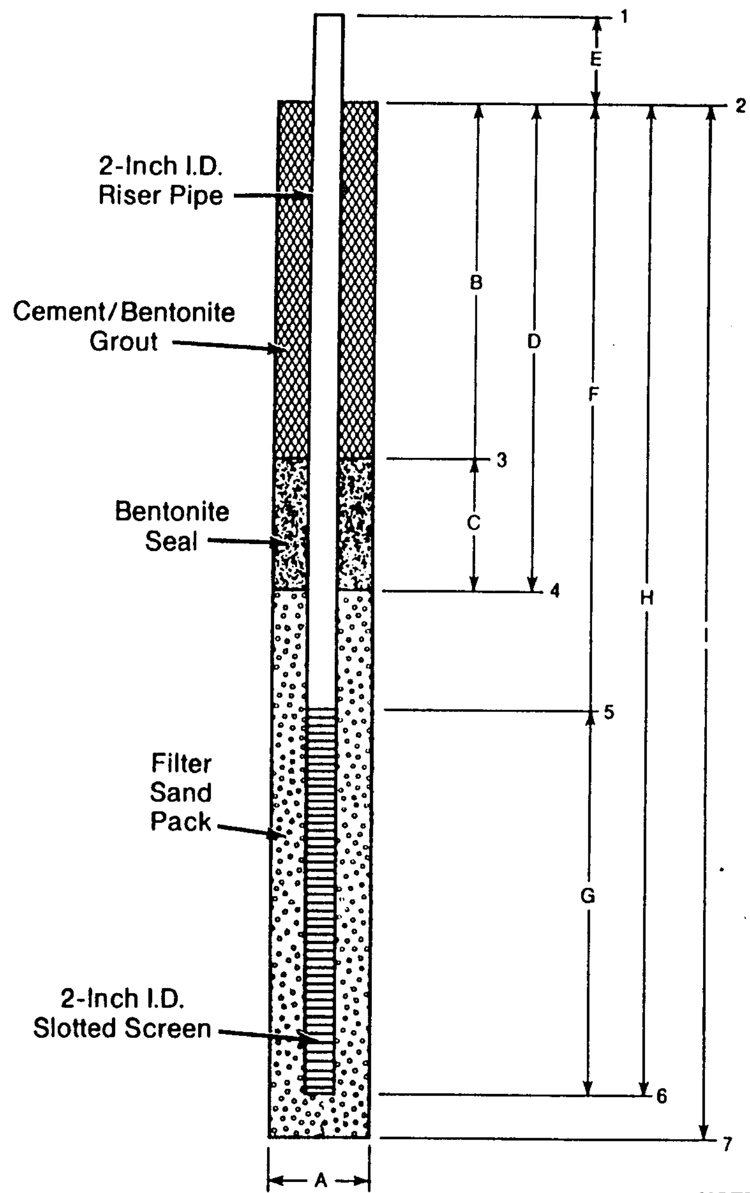


FIGURE 3-7 TUCKER CREEK LANDFILL (TCLF) SITE MAP



Well Number		05-130	05-132	05-134	05-167
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	1.1	1	1.1	2.9
Thickness of Bentonite Seal	C	2.4	2.25	1.9	2
Depth of Seal	D	3.5	3.25	3	4.9
Riser Stick-Up	E	2.34	2.74	2.36	2.11
In-Ground Riser	F	5	4.8	4.3	7
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	15.3	15.1	14.6	17.3
Depth of Borehole	I	17	15.5	15	20
Top of Riser Elev.	1	577.48	575.11	578.71	577.03
Ground Surface Elev.	2	575.14	572.37	576.35	574.92
Top of Seal Elev.	3	574.04	571.37	575.25	572.02
Bottom of Seal Elev.	4	571.64	569.12	573.35	570.02
Top of Screen Elev.	5	570.14	567.57	572.05	567.92
Bottom of Screen Elev.	6	559.84	557.27	561.75	557.62
Bottom of Borehole Elev.	7	558.14	556.87	561.35	554.92

Well Number		05-231	05-233	05-235
Borehole Diameter (inches)	A	8	8	8
Depth of Concrete	B	18.1	19.5	17
Thickness of Bentonite Seal	C	3.1	2.2	2
Depth of Seal	D	21.2	21.7	19
Riser Stick-Up	E	2.35	3.69	1.98
In-Ground Riser	F	23.2	24.4	21.66
Screen Length	G	10.3	10.3	10.3
Depth of Screen	H	33.5	34.7	31.96
Depth of Borehole	I	35.1	35.5	34
Top of Riser Elev.	1	577.49	576.06	580.06
Ground Surface Elev.	2	575.14	572.37	578.08
Top of Seal Elev.	3	557.04	552.87	561.08
Bottom of Seal Elev.	4	553.94	550.67	559.08
Top of Screen Elev.	5	551.94	547.97	556.42
Bottom of Screen Elev.	6	541.64	537.67	546.12
Bottom of Borehole Elev.	7	540.04	536.87	544.08

NOTE: All measurements in feet except borehole diameter. Elevations in feet above mean sea level.

TABLE 3-7 TCLF MONITOR WELL SPECIFICATIONS, SELFRIDGE ANGB

on the eastern perimeter. All soil borings were drilled to a depth of 30 feet, except for 05-417, which was terminated at a depth of 25 feet because of auger refusal.

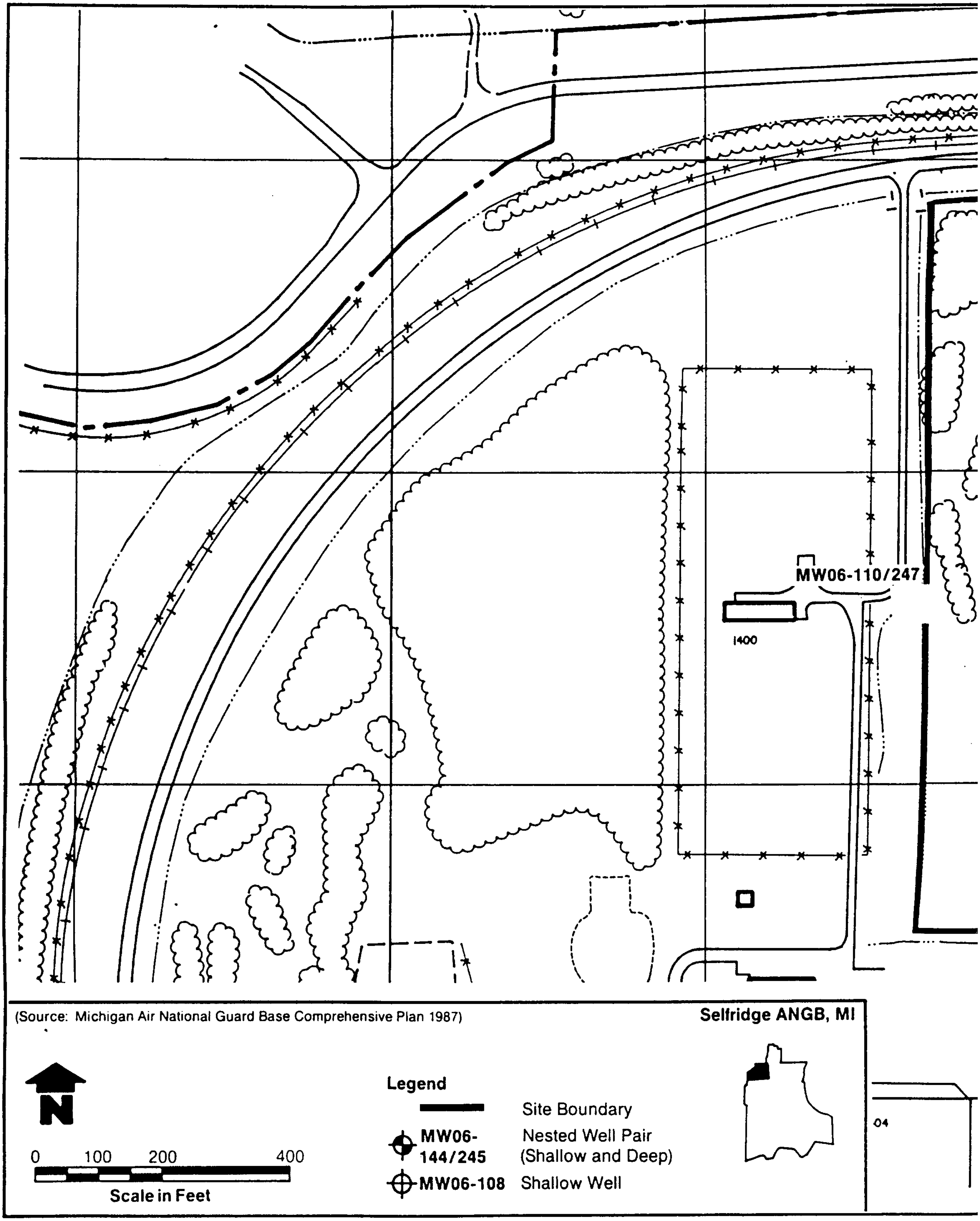
Six wells were established at TCLF during the Stage 2 drilling program. The first two were paired as a well nest, 05-132/233, and were installed in a downgradient location at the southeastern corner of the site. A second well nest, 05-130/231, was installed in a downgradient location along the eastern part of the site. Well 05-134 was positioned near the approximate center of the former landfill. Deep well 05-235 was located in an upgradient position, west of the site, immediately adjacent to the Stage 1 well 05-105 (W-5).

The destroyed Stage 1 well 05-106 (W-6) was replaced during the Stage 2 drilling program at TCLF. Abandonment of 05-106 consisted of pulling the well from the ground and grouting the borehole to the surface, in accordance with Michigan DNR regulations. The replacement well, 05-167, was installed in a downgradient location along the eastern perimeter of the site. The abandoned well 05-106 had a 20-foot screen to a depth of 26 feet, and the replacement well, 05-167, has a 10-foot screen to a depth of 16 feet.

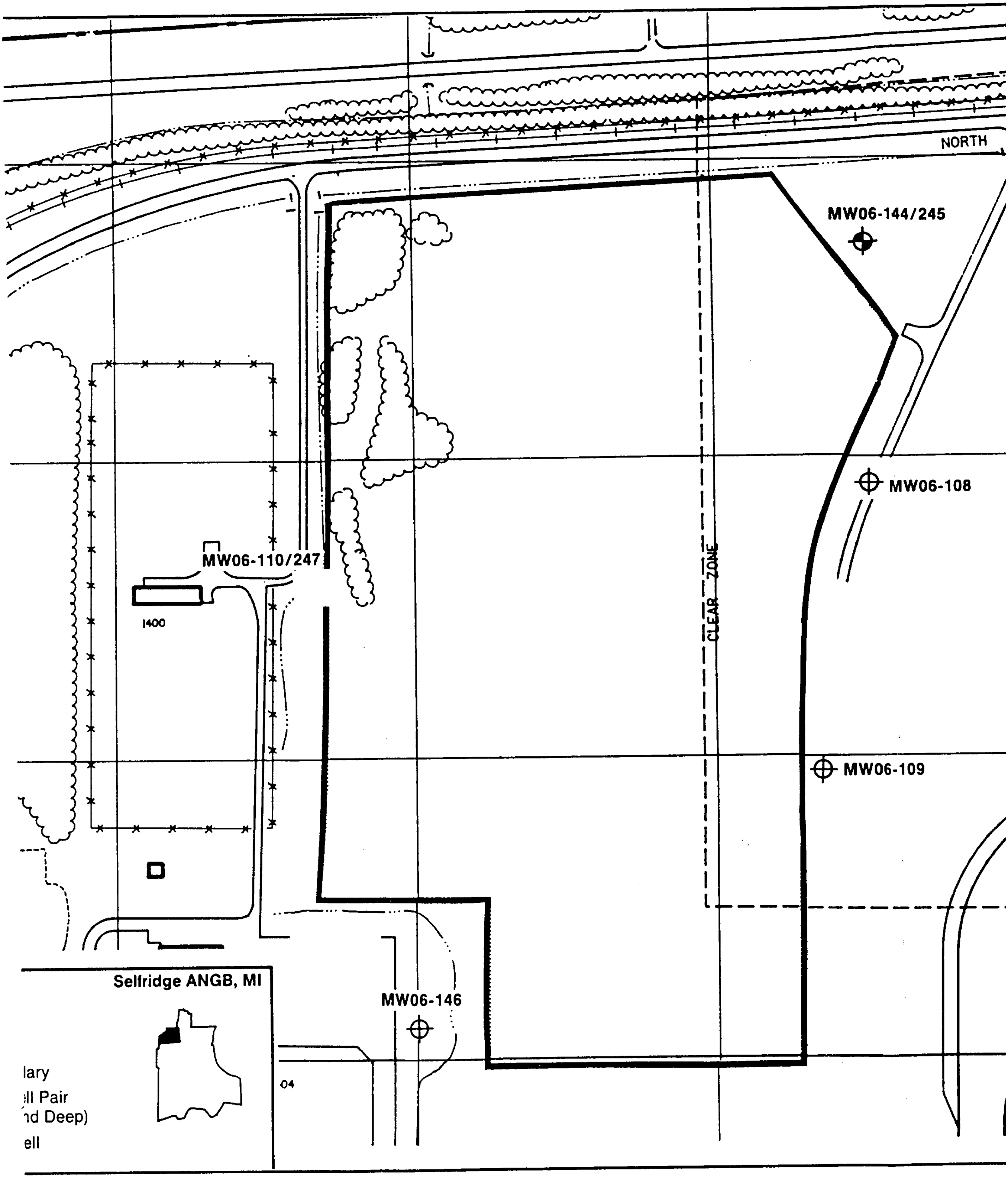
The Stage 2 groundwater monitor wells at TCLF were installed with 10-foot screens. The shallow wells were set at depths between 15 and 16 feet; the deep wells were set at depths between 32 and 36 feet. The shallow wells generally were screened in laminated, mottled, silty clay and the underlying gray clay to silty clay. Deep wells at the site were screened predominantly in gray sandy clay to clayey sand. The bottom 1 to 2 feet of screen in deep wells 05-231 and 05-233 penetrated the underlying hard silt, sand, and gravel layer discussed in connection with the soil borings drilled at the site. The monitor wells were screened in fine-grained soils because there are no significant, wide-spread coarse-grained deposits in the subsurface at this site. The top of the saturated zone was encountered during drilling of the Stage 2 soil borings and groundwater monitor wells at TCLF between depths of 7 and 13 feet.

3.4.3.6 Site 6: Northwest Landfill (NWLF)

There were no soil borings done at NWLF during the Stage 2 drilling program. However, soil samples were collected from two deep monitor well borings (06-345 and 06-347) as described in Subsection 3.6.1 of this report. Four groundwater monitor wells, consisting of two well nests, were installed at NWLF during the Stage 2 drilling program. Locations are shown in Figure 3-8 and well specifications in Table 3-8. The purpose of the wells was to further define groundwater contaminants detected at the site in the Stage 1 investigation. The four Stage 2 wells expand the groundwater monitor network at NWLF from the



MW06-110/247
1400
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0 100 200 400
Scale in Feet
Legend
Site Boundary
MW06-144/245 Nested Well Pair (Shallow and Deep)
MW06-108 Shallow Well
04



NORTH
MW06-144/245
MW06-108
MW06-110/247
1400
CLEAR ZONE
MW06-109
MW06-146
Selfridge ANGB, MI
lary
ll Pair
nd Deep)
ell
04

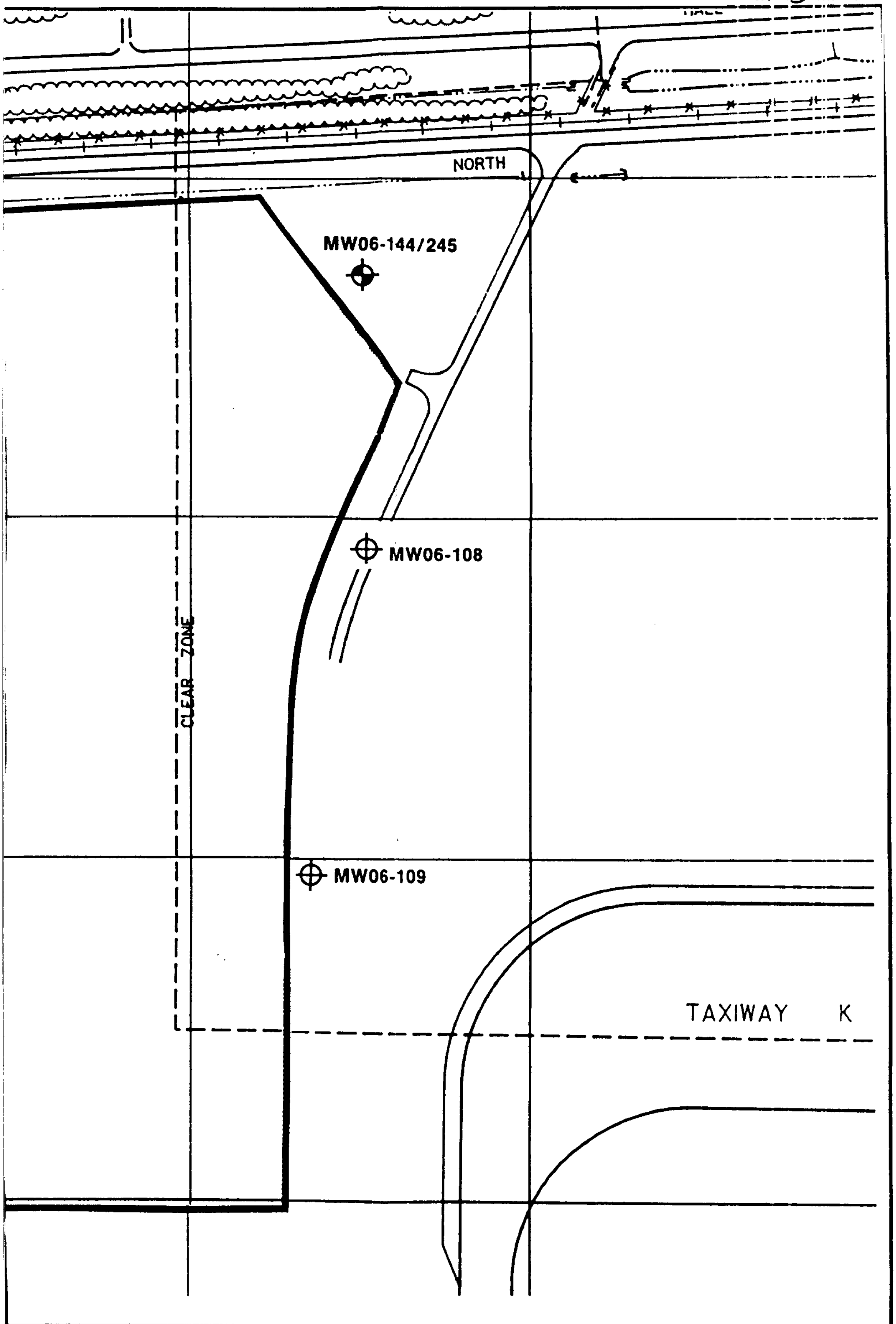
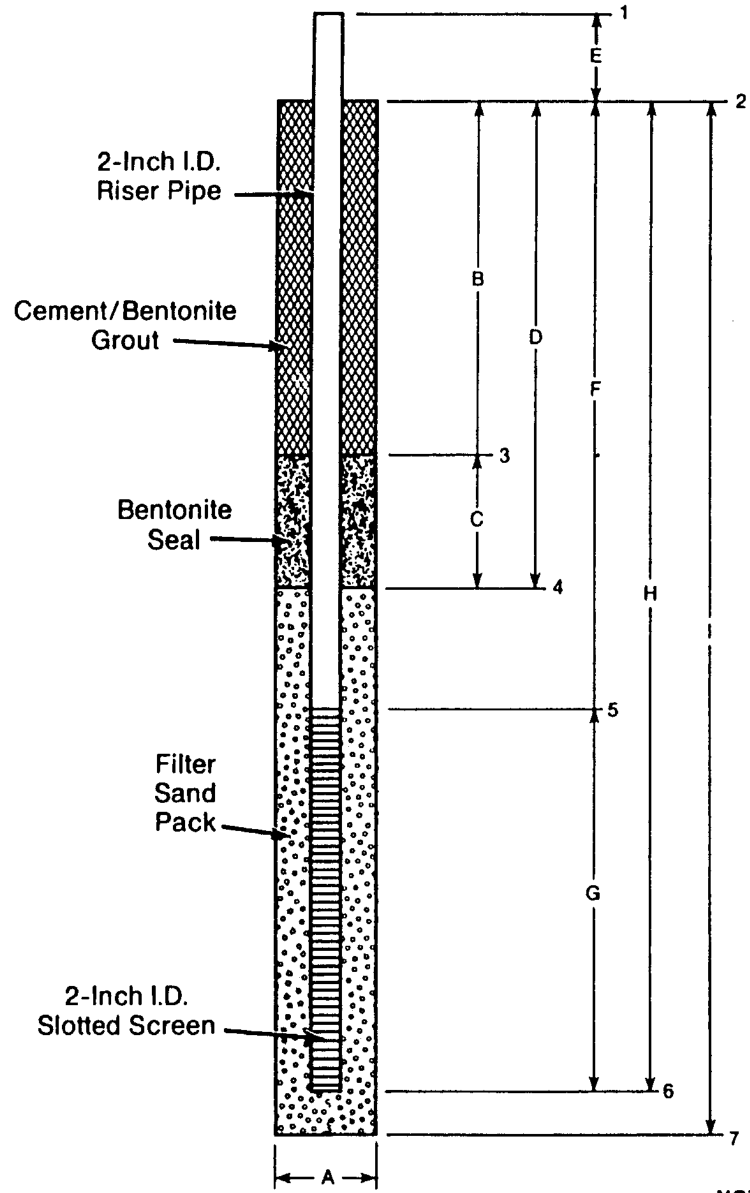


FIGURE 3-8 NORTHWEST LANDFILL (NWLF) SITE MAP



Well Number		06-144	06-146	06-245	06-247
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	2.2	0.5	17	13.5
Thickness of Bentonite Seal	C	2.22	2.33	2	2
Depth of Seal	D	4.42	2.83	21	15.5
Riser Stick-Up	E	2.47	3.99	2.32	1.99
In-Ground Riser	F	6.75	5	24.3	17
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	17.05	15.3	34.6	27.3
Depth of Borehole	I	18.5	18.5	35	28
Top of Riser Elev.	1	587.70	583.98	587.55	583.54
Ground Surface Elev.	2	585.23	579.99	585.23	581.55
Top of Seal Elev.	3	583.03	579.49	568.23	568.05
Bottom of Seal Elev.	4	580.81	577.16	566.23	566.05
Top of Screen Elev.	5	578.48	574.99	560.93	564.55
Bottom of Screen Elev.	6	568.18	564.69	550.63	554.25
Bottom of Borehole Elev.	7	566.73	561.49	550.23	553.55

NOTE: All measurements in feet except borehole diameter. Elevations in feet above mean sea level.

TABLE 3-8 NWLF MONITOR WELL SPECIFICATIONS, SELFRIDGE ANGB

three existing wells to a total of seven wells. Groundwater sampling of these wells is described in Subsection 3.6.2 of this report.

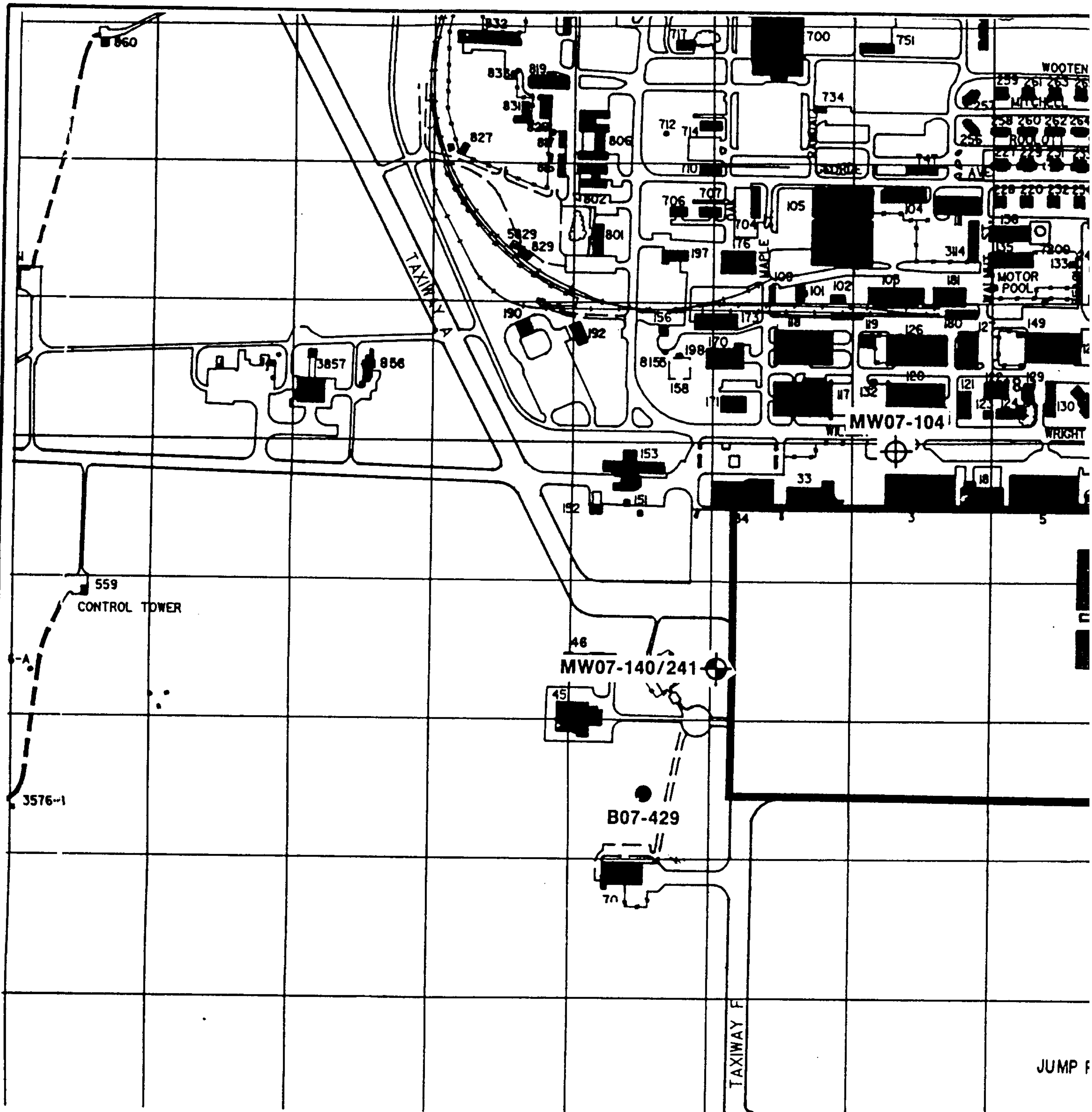
Shallow well 06-144 and its deep counterpart 06-245 were installed in a downgradient position at NWLF, near the northeastern corner of the site. Shallow well 06-146 was located in an upgradient location at the southwestern corner of the landfill. Deep well 06-246 was positioned adjacent to Stage 1 well 06-110 (W-10) along the western perimeter of the site. The deep wells were set at depths between 27 and 35 feet, while the shallow wells were placed at depths between 15 and 18 feet.

All Stage 2 wells at NWLF were installed with 10-foot screens. Deep well 06-245 was screened in gray clay to silty clay and the underlying gravely silt. Well 06-247 was screened in gray clay to silty clay and the underlying sandy clay to clayey sand. Well 06-144 was screened in the hard silty clay and brown sand overlying gray silty clay. Well 06-146 was screened in brown silty clay to clayey silt and the underlying gray silty clay. The monitor wells were screened in fine-grained soils because there are no significant, wide-spread coarse-grained deposits in the subsurface at this site. The top of the saturated zone was encountered between 10 and 12 feet during drilling of the groundwater monitor well borings at NWLF.

3.4.3.7 Site 7: East Ramp (ERMP)

Two soil borings were drilled and eight groundwater monitor wells installed at ERMP during the Stage 2 field investigation. Locations are shown in Figure 3-9 and well specifications in Table 3-9. The soil borings were located adjacent to stormwater catch basins to ascertain whether soil in these areas had been affected by runoff of possible contaminated stormwater runoff. Soil sampling procedures are described in Subsection 3.6.1 of this report. The purpose of the groundwater monitor wells was to further define groundwater contaminants detected in the Stage 1 wells at the site. By establishing well nests around the site perimeter, the groundwater monitor network at the site was expanded from 3 Stage 1 wells to 11 total wells. A fourth Stage 1 well, 07-101 (W-1), was never located and is presumed to be destroyed, possibly when the ramp was repaired or when a water line near the ramp was installed. Groundwater sampling procedures are described in Subsection 3.6.2 of this report.

The two soil borings drilled at ERMP during the Stage 2 drilling program were located at the northeastern and southwestern corners of the site. Both borings, 07-428 and 07-429, were advanced to 30 feet. The top of the saturated zone was encountered at 9 and 10 feet in 07-428 and 07-429, respectively. The site stratigraphy is discussed below, in connection with the groundwater monitor wells installed at ERMP during the Stage 2 drilling program.



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

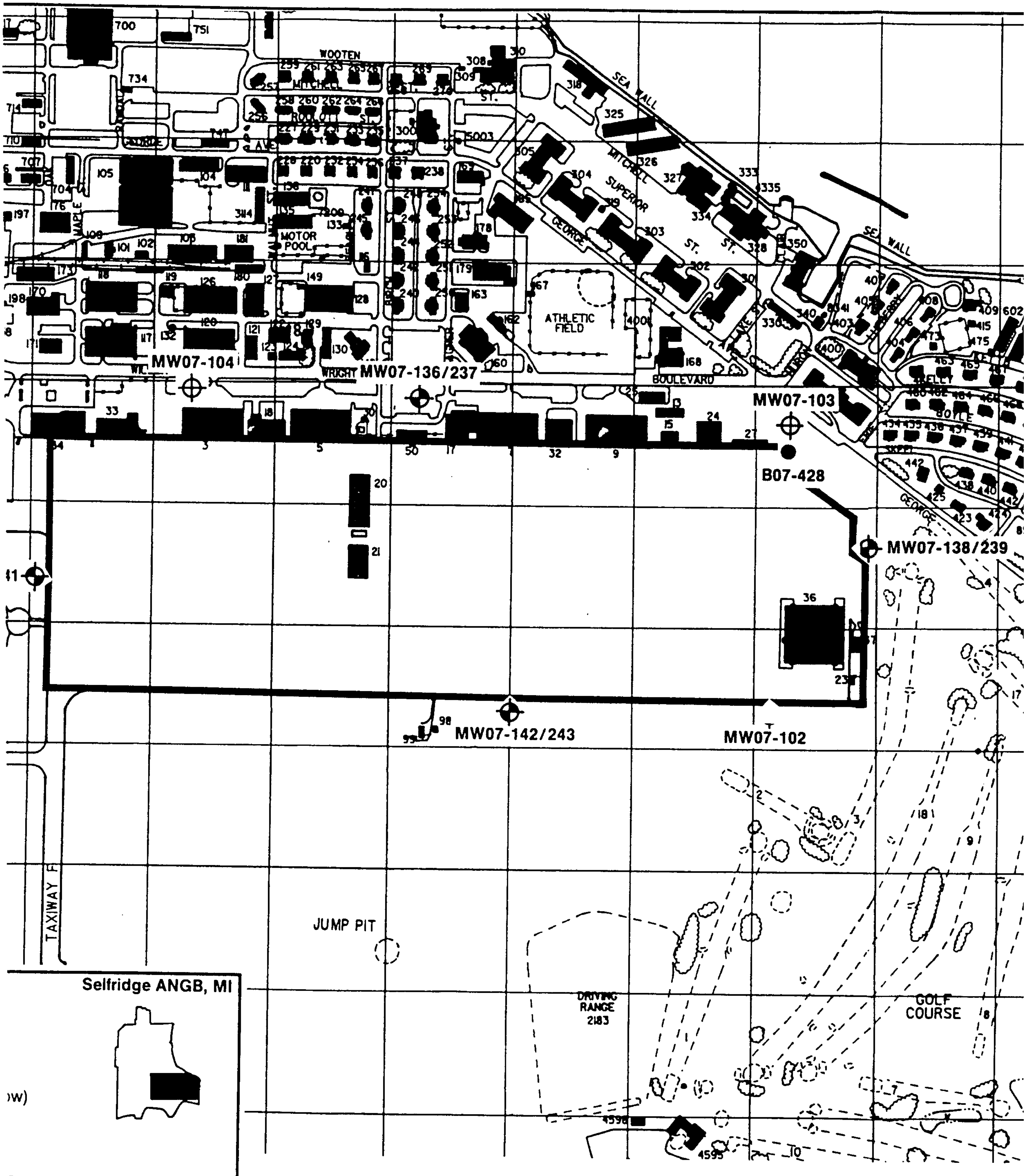
N

Legend

(line)	Site Boundary
MW07-137/237	Nested Well Pair (Deep and Shallow)
MW07-102	Shallow Well
B07-429	Soil Boring

0 250 500 1000

Scale in Feet



MW07-104
MW07-136/237
MW07-103
B07-428
MW07-138/239
MW07-142/243
MW07-102
JUMP PIT
DRIVING RANGE 2183
GOLF COURSE
ATHLETIC FIELD
MOTOR POOL
TAXIWAY F
WOOTEN
MITCHELL
SEA WALL
SUPERIOR
GEORGE
BOULEVARD
WRIGHT
BOYLE
Selfridge ANGB, MI

FI

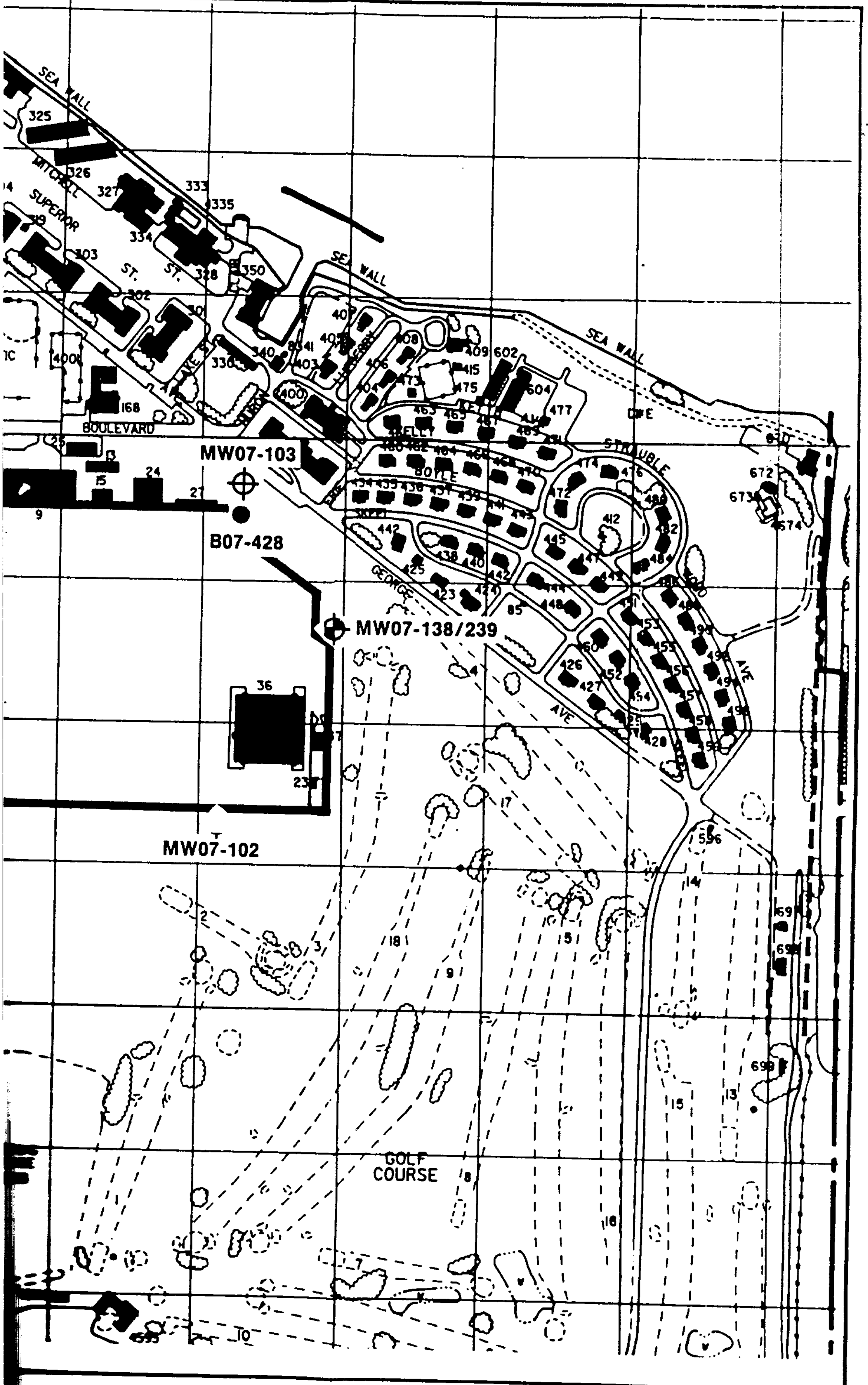
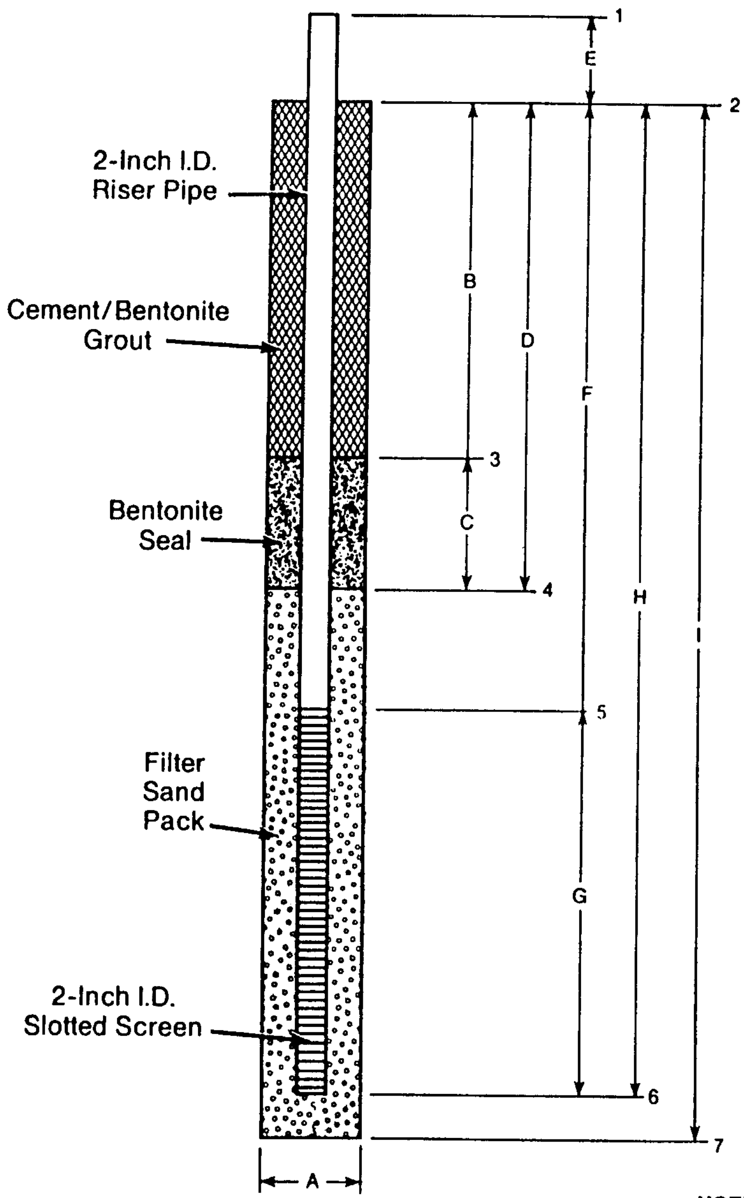


FIGURE 3-9 EAST RAMP (ERMP) SITE MAP



Well Number		07-136	07-138	07-140	07-142
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	2	1	1	1
Thickness of Bentonite Seal	C	2.5	2	2	2
Depth of Seal	D	4.5	3	3	3
Riser Stick-Up	E	2.08	2.24	2.18	2.16
In-Ground Riser	F	7	4.64	5	5
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	17.3	14.94	15.3	15.3
Depth of Borehole	I	18.7	17	17	16.5
Top of Riser Elev.	1	577.61	576.66	578.23	579.15
Ground Surface Elev.	2	575.53	574.42	576.05	576.99
Top of Seal Elev.	3	573.53	573.42	575.05	575.99
Bottom of Seal Elev.	4	571.03	571.42	573.05	573.99
Top of Screen Elev.	5	568.23	569.78	571.05	571.99
Bottom of Screen Elev.	6	558.23	559.48	560.75	561.69
Bottom of Borehole Elev.	7	556.83	557.42	559.05	560.49

Well Number		07-237	07-239	07-241	07-243
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	24.3	21	20.1	21
Thickness of Bentonite Seal	C	1	2	2	2.6
Depth of Seal	D	25.3	23	22.1	23.6
Riser Stick-Up	E	2.78	1.95	2.29	2.32
In-Ground Riser	F	27.5	25	25	25
Screen Length	G	10.3	10.3	10.3	10.3
Depth of Screen	H	37.8	35.3	35.3	35.3
Depth of Borehole	I	38.5	37	36	39
Top of Riser Elev.	1	578.31	576.37	578.34	579.31
Ground Surface Elev.	2	575.53	574.42	576.05	576.99
Top of Seal Elev.	3	551.23	553.42	555.95	555.99
Bottom of Seal Elev.	4	550.23	551.42	553.95	553.39
Top of Screen Elev.	5	548.03	549.42	551.05	551.99
Bottom of Screen Elev.	6	537.73	539.12	540.75	541.69
Bottom of Borehole Elev.	7	537.03	537.42	540.05	537.99

NOTE: All measurements in feet except borehole diameter. Elevations in feet above mean sea level.

TABLE 3-9 ERMP MONITOR WELL SPECIFICATIONS, SELFRIDGE ANGB

A groundwater monitor well nest was installed along each of the four site perimeters at ERMP. Well nest 07-138/239 was installed in a downgradient position east of the site, on an adjacent portion of the base golf course. Well nest 07-136/237 was installed in a downgradient position north of the site, in front of the Base Operations Building (Building 50). Well nest 07-142/243 was installed in an upgradient position on the southern perimeter of the ramp. Well nest 07-140/241 was installed in an upgradient position at the western boundary of the site.

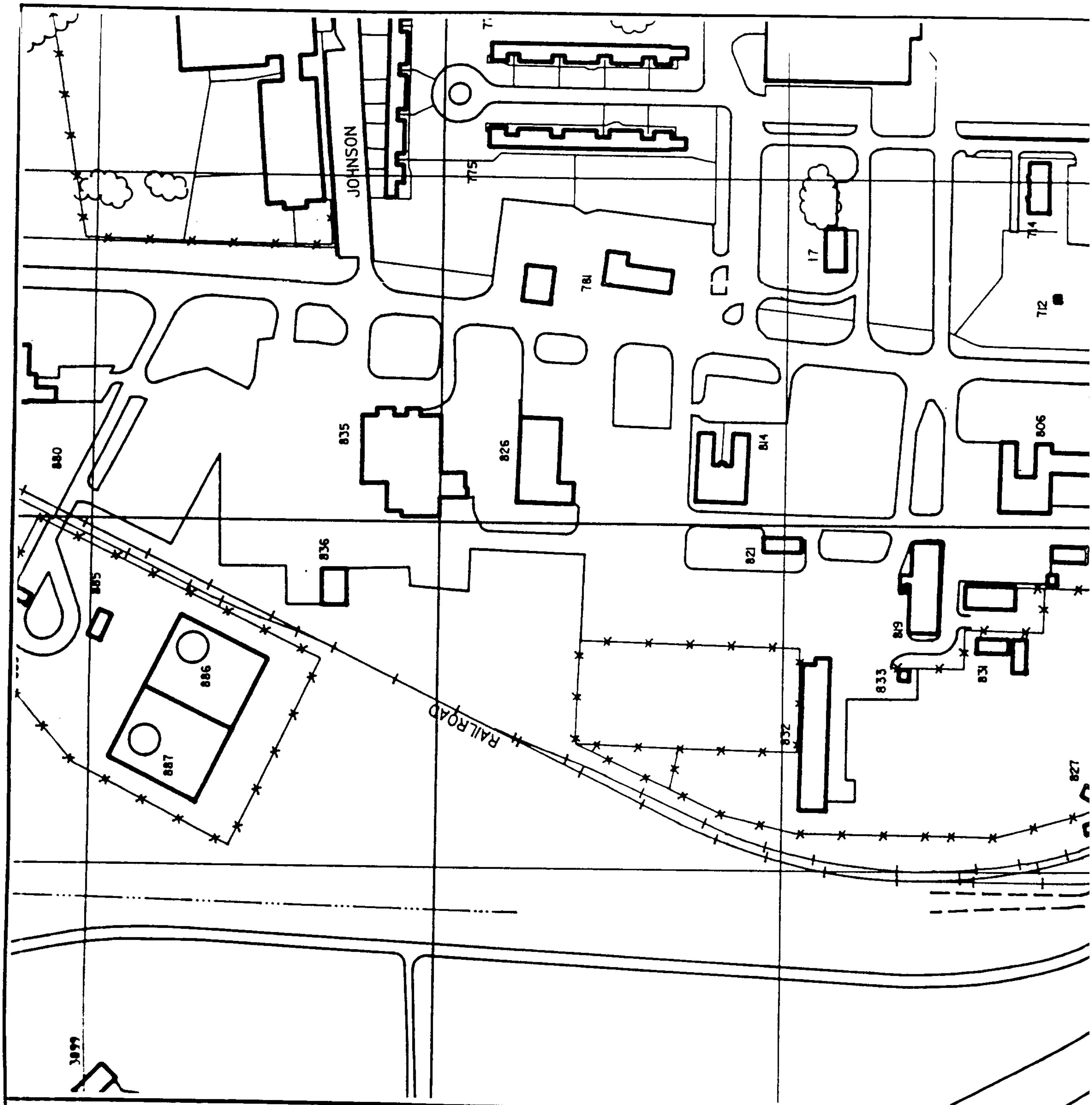
All Stage 2 wells at ERMP were installed with 10-foot screens. The shallow wells were screened in mottled, laminated silt and clay and the underlying gray clay to silty clay. Three of the deep wells at the site, 07-237, 07-239, and 07-241, were screened in gray clay to silty clay and the underlying sandy clay to clayey sand. Well 07-243 was screened entirely in gray silty clay. The monitor wells were screened in fine-grained soils because there are no significant, wide-spread coarse-grained deposits in the subsurface at this site. The top of the saturated zone was encountered during drilling of the groundwater monitor wells at depths ranging from 10 to 12 feet.

3.4.3.8 Site 8: Base Coal Storage Pile (BCSP)

BCSP was not identified during the Phase I record search as a potential hazardous site at Selfridge ANGB and was not included in the Phase II Stage 1 investigation. Selfridge ANGB staff requested that BCSP be added to the list of sites to be investigated during the IRP Stage 2 study.

The Stage 2 drilling program at BCSP consisted of drilling three soil borings and installing four shallow groundwater monitor wells. Locations are shown in Figure 3-10 and well specifications in Table 3-10. The soil borings were located as close as possible to the coal piles to determine whether leachate from the coal had affected soil in the immediate vicinity of the piles. Soil sampling is described in Subsection 3.6.1 of this report. One monitor well was placed upgradient of BCSP, while the remaining three were placed downgradient. The purpose of the groundwater monitor wells was to determine whether leachate from the coal had affected groundwater at the site. Groundwater sampling is described in Subsection 3.6.2 of this report.

Four shallow groundwater monitor wells were installed at BCSP during the Stage 2 drilling program. Well 08-128 was installed in an upgradient position, southwest of a railroad spur that follows the southern and western perimeters of the site. Wells 08-127, 08-126, and 08-129 were installed in downgradient locations at the southeastern, northeastern, and northwestern corners of the site, respectively.



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

Legend

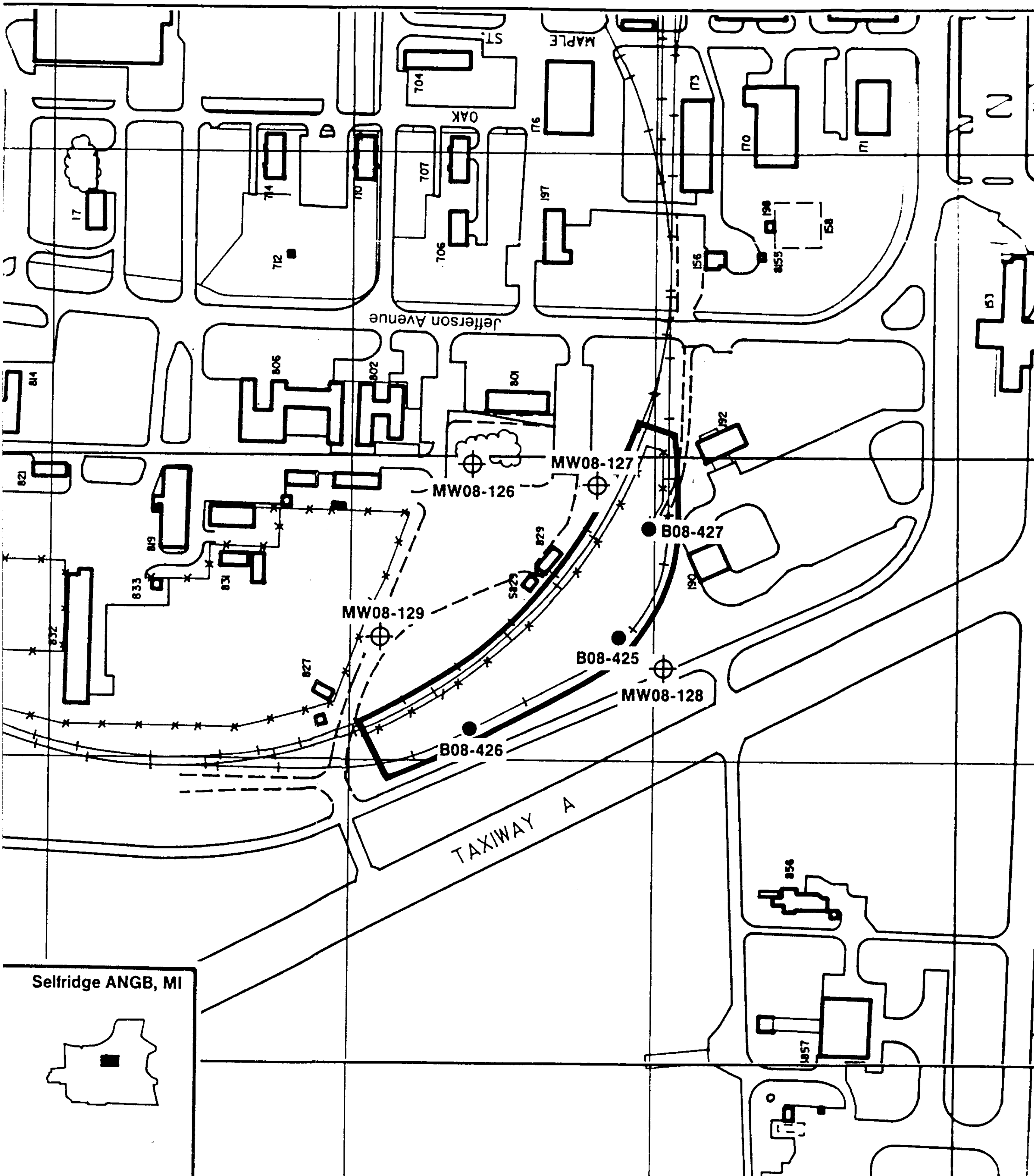
Site Boundary

MW08-126 Shallow Well

B08-426 Soil Boring

0 100 200 400

Scale in Feet



MAPLE
ST.
OAK
Jefferson Avenue
MW08-127
MW08-126
MW08-129
MW08-128
B08-427
B08-425
B08-426
TAXIWAY A
Selfridge ANGB, MI

FIGURE 3-

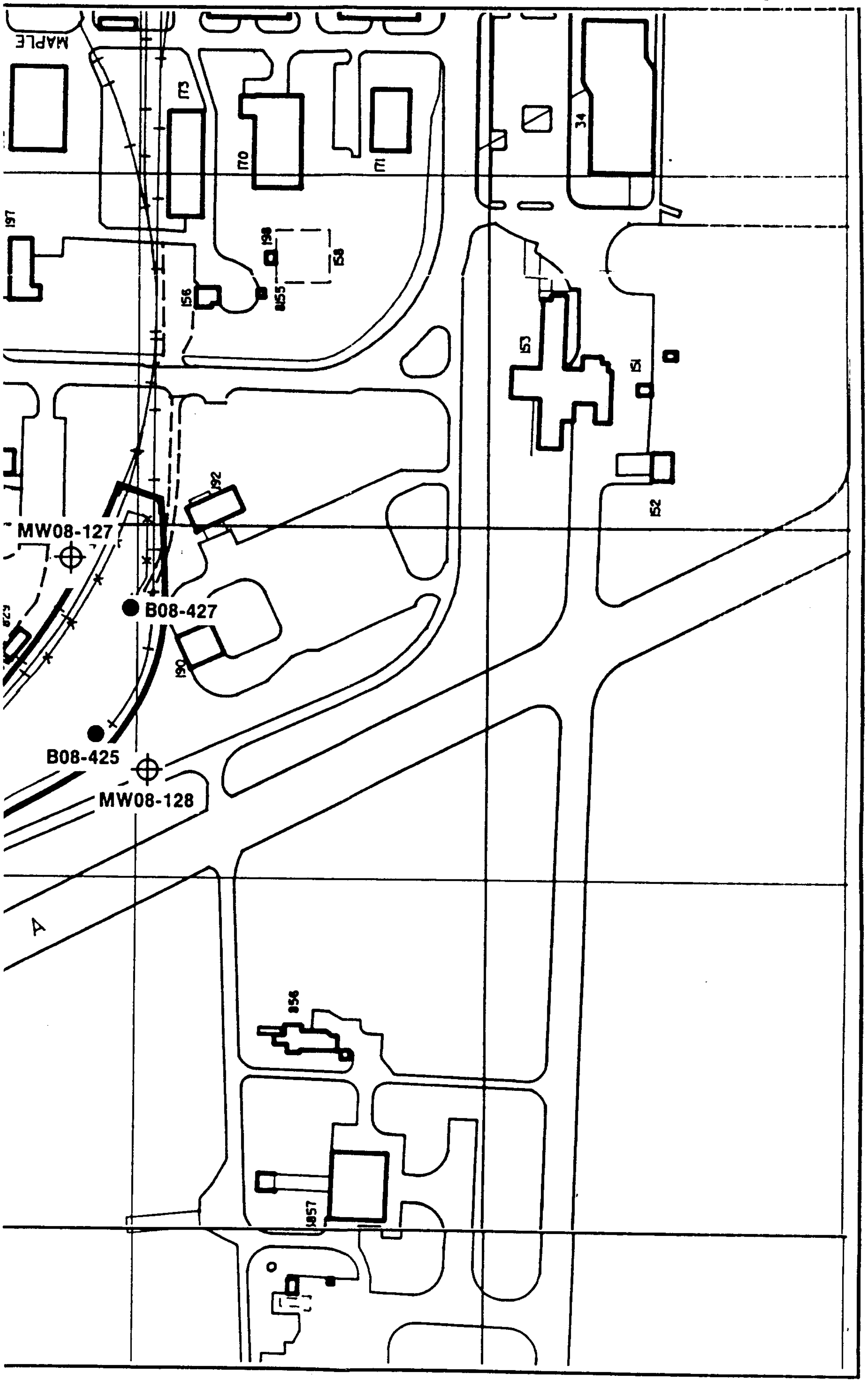
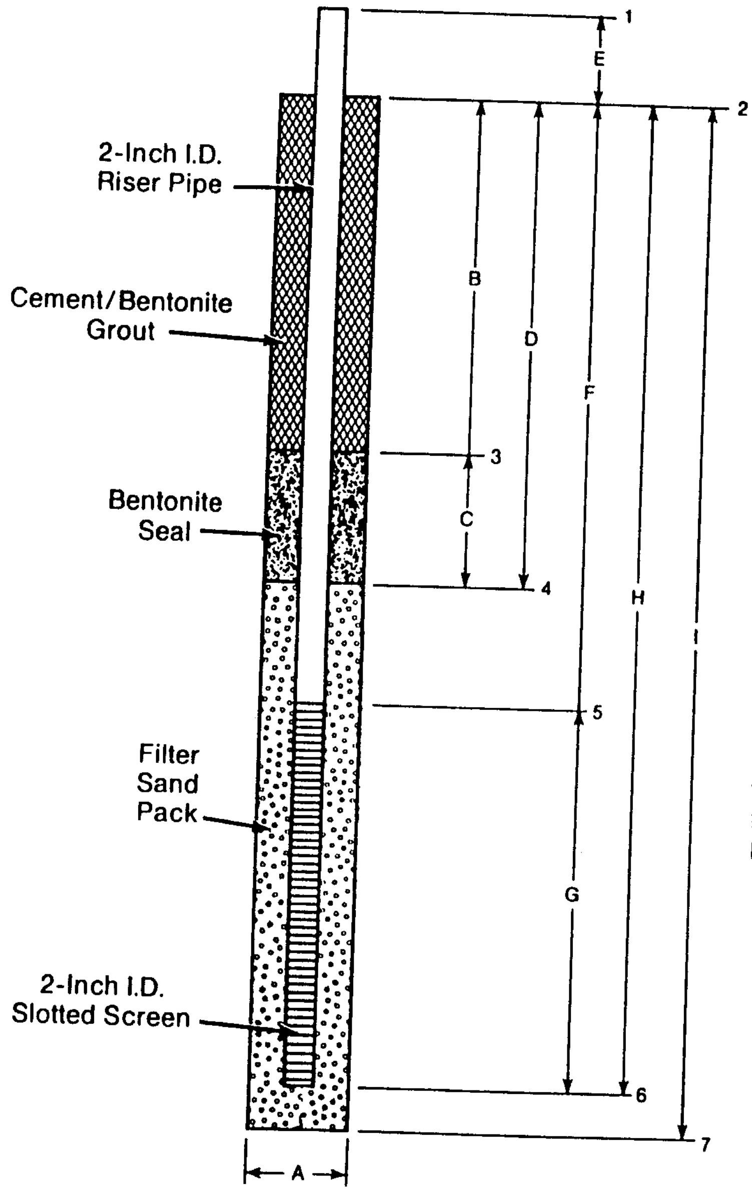


FIGURE 3-10 BASE COAL STORAGE PILE (BCSP) SITE MAP



Well Number		08-126	08-127	08-128	08-129
Borehole Diameter (inches)	A	8	8	8	8
Depth of Concrete	B	3	5	2.7	2.9
Thickness of Bentonite Seal	C	3	2	2.5	2
Depth of Seal	D	6	7	5.2	4.9
Riser Stick-Up	E	2.23	2.4	2.34	3.34
In-Ground Riser	F	10	9.3	7.05	6.64
Screen Length	G	10.2	10.3	10.3	10.3
Depth of Screen	H	20.3	19.6	17.35	16.94
Depth of Borehole	I	25	20	18	19
Top of Riser Elev.	1	579.23	580.51	580.29	580.3
Ground Surface Elev.	2	577	578.11	577.95	576.96
Top of Seal Elev.	3	574	573.11	575.25	574.06
Bottom of Seal Elev.	4	571	571.11	572.75	572.06
Top of Screen Elev.	5	567	568.81	570.9	570.32
Bottom of Screen Elev.	6	556.7	558.51	560.6	560.02
Bottom of Borehole Elev.	7	552	558.11	559.95	557.96

NOTE: All measurements in feet except borehole diameter. Elevations in feet above mean sea level.

TABLE 3-10 BCSP MONITOR WELL SPECIFICATIONS, SELFRIDGE ANGB

The wells were installed with 10-foot screens to depths ranging from 17 to 21 feet. The lithology of the screened interval generally consisted of mottled, laminated, brown silty clay and the underlying gray clay to silty clay. The monitor wells were screened in fine-grained soils because there are no significant, wide-spread coarse-grained deposits in the subsurface at this site. During drilling of the groundwater monitor wells at the site, the top of the saturated zone was reached between depths of 10.5 and 12 feet.

3.4.4 Footage Summary

Twenty-nine exploratory soil borings, totaling 863 feet, were drilled at Selfridge ANGB during the Phase II Stage 2 drilling program (see Table 3-11). Forty-two groundwater monitor wells, totaling 992.87 feet, were installed (see Table 3-12).

3.5 HYDROGEOLOGIC FIELD INVESTIGATION METHODS

Field investigation of groundwater flow at Selfridge ANGB included three separate activities:

- Multiple rounds of water level measurements in all groundwater monitor wells.
- Continuous water level recordings at three pairs of monitor wells and stormwater inlets.
- Determination of hydraulic conductivity at all monitor well locations from baildown-recovery test data.

These activities are discussed in Subsections 3.5.1 through 3.5.3 of this report.

3.5.1 Water Level Surveys

Seven rounds of groundwater level measurements were taken from all Selfridge ANGB wells over a 5-month period. The measurements were obtained using the procedures set forth in Subsection 2.2.4 of the approved QAPP prior to development, prior to slug testing, prior to sampling, and on four other occasions. The depth-to-water readings were obtained relative to the top of the inner steel casing with an electric water level probe or weighted tape. This equipment was decontaminated between uses as specified in Subsection 2.6.3 of the approved QAPP. The reference elevation was determined to the nearest 0.01 foot and the well locations horizontally located to an accuracy of 1 foot. Surveying was performed by Grant Ward Surveyors. Static water level measurements collected during the IRP Stage 2 investigation are summarized in Table 3-13.

Table 3-11

Soil Boring Footage Summary, IRP Stage 2, Selfridge ANGB, MI

Site Name	Number of Borings	Borehole Footage (ft)
Southwest Landfill	0	0
Fire Training Area 2	3	90
Fire Training Area 1	3	90
West Ramp	10	298
Tucker Creek Landfill	8	235
Northwest Landfill	0	0
East Ramp	2	60
Base Coal Storage Pile	3	90
Total	29	863

Table 3-12

Monitor Well Footage Summary, IRP Stage 2, Selfridge ANGB, MI

Site Name	Number of Wells	Well Footage (ft)
Southwest Landfill	8	209.45
Fire Training Area 2	3	49.70
Fire Training Area 1	0	0
West Ramp	8	188.60
Tucker Creek Landfill	7	164.60
Northwest Landfill	4	95.85
East Ramp	8	209.22
Base Coal Storage Pile	4	75.45
Total	42	992.87

Table 3-13

Water Level Elevations, IRP Stage 2, Selfridge ANGB, MI

Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 2/1/88	Water Level Elevation 2/1/88	Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 2/1/88	Water Level Elevation 2/1/88
SWLF	01-122	583.04	4.75	578.29	TCLF	05-134	578.71	6.47	572.24
	01-123	583.04	4.21	578.83		05-167	577.03	NI	NI
	01-124	585.72	4.98	580.74		05-231	577.49	29.37	548.12
	01-125	584.98	5.83	579.15		05-233	576.06	NI	NI
	01-156	584.71	NI	NI		05-235	580.06	5.75	574.31
	01-158	586.31	NI	NI		05-601	575.27	CW	CW
	01-160	583.67	NI	NI		05-602	575.06	CW	CW
	01-162	585.26	NI	NI		05-603	576.72	CW	CW
	01-257	583.46	NI	NI		05-604	575.93	CW	CW
	01-259	586.09	NI	NI		05-605	575.9	CW	CW
	01-261	583.17	NI	NI		05-606	577.77	CW	CW
	01-263	585.07	8.91	576.16	NWLF	06-108	589.24	6.18	583.06
FTA-2	02-164	580.42	5.37	575.05		06-109	583.81	1.50	582.31
	02-165	581.55	5.75	575.8		06-110	583.53	9.75	573.78
	02-166	581.89	NI	NI		06-144	587.70	5.00	582.7
FTA-1	03-116	579.89	2.29	577.6		06-146	583.98	NI	NI
	03-117	580.06	3.23	576.83		06-245	587.55	NI	NI
	03-118	580.64	3.27	577.29		06-247	583.54	NI	NI
WRMP	04-111	578.41	2.75	575.66	ERMP	07-102	578.20	5.33	572.87
	04-112	581.12	4.46	576.66		07-103	576.72	6.58	570.14
	04-113	581.07	1.91	579.16		07-104	577.89	6.52	571.37
	04-115	582.24	5.83	576.41		07-136	577.61	7.21	570.4
	04-148	582.08	15.69	566.39		07-138	576.66	NI	NI
	04-150	581.71	NI	NI		07-140	578.23	NI	NI
	04-152	582.00	16.80	565.2		07-142	579.15	NI	NI
	04-154	580.87	4.58	576.29		07-237	578.31	8.68	569.63
	04-249	581.54	NI	NI		07-239	576.37	NI	NI
	04-251	581.12	NI	NI		07-241	578.34	NI	NI
	04-253	582.15	6.53	575.62		07-243	579.31	NI	NI
	04-255	580.34	4.87	575.47	BCSP	08-126	579.23	16.65	562.58
TCLF	05-105	579.55	3.33	576.22		08-127	580.51	5.87	574.64
	05-107	576.54	8.00	568.54		08-128	580.29	15.57	564.72
	05-130	577.48	4.54	572.94		08-129	580.3	5.66	574.64
	05-132	575.11	2.71	572.4					

(1) - All depth to water and groundwater elevations measured from top of inner casing.
F - Water frozen at top of ground surface.
NI/P - Not installed as of this date/first (old) well plugged.
NI - Not installed as of this date.
CW - Clayton Wells (600 series) were locked and inaccessable to WESTON until June 1988.

Table 3-13
(continued)

Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 3/4/88	Water Level Elevation 3/4/88	Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 3/4/88	Water Level Elevation 3/4/88
SWLF	01-122	583.04	3.82	579.22	TCLF	05-134	578.71	6.22	572.49
	01-123	583.04	3.70	579.34		05-167	577.03	14.10	562.93
	01-124	585.72	4.11	581.61		05-231	577.49	8.64	568.85
	01-125	584.98	5.12	579.86		05-233	576.06	NI/P	NI/P
	01-156	584.71	3.83	580.88		05-235	580.06	5.83	574.23
	01-158	586.31	4.65	581.66		05-601	575.27	CW	CW
	01-160	583.67	4.80	578.87		05-602	575.06	CW	CW
	01-162	585.26	4.97	580.29		05-603	576.72	CW	CW
	01-257	583.46	NI	NI		05-604	575.93	CW	CW
	01-259	586.09	10.13	575.96		05-605	575.9	CW	CW
	01-261	583.17	8.20	574.97		05-606	577.77	CW	CW
	01-263	585.07	8.91	576.16	NWLF	06-108	589.24	5.96	583.28
FTA-2	02-164	580.42	4.18	576.24		06-109	583.81	F	F
	02-165	581.55	7.30	574.25		06-110	583.53	5.03	578.5
	02-166	581.89	16.33	565.56		06-144	587.70	5.32	582.38
FTA-1	03-116	579.89	F	F		06-146	583.98	5.78	578.2
	03-117	580.06	2.89	577.17		06-245	587.55	6.98	580.57
	03 118	580.64	3.01	577.63		06-247	583.54	5.25	578.29
WRMP	04-111	578.41	F	F	ERMP	07-102	578.20	4.58	573.62
	04-112	581.12	3.31	577.81		07-103	576.72	5.79	570.93
	04-113	581.07	F	F		07-104	577.89	5.65	572.24
	04-115	582.24	5.23	577.01		07-136	577.61	7.02	570.59
	04-148	582.08	10.82	571.26		07-138	576.66	7.88	568.78
	04-150	581.71	6.20	575.51		07-140	578.23	8.00	570.23
	04-152	582.00	9.30	572.7		07-142	579.15	3.13	576.02
	04-154	580.87	3.45	577.42		07-237	578.31	7.44	570.87
	04-249	581.54	3.81	577.73		07-239	576.37	4.61	571.76
	04-251	581.12	5.11	576.01		07-241	578.34	10.82	567.52
	04-253	582.15	6.08	576.07		07-243	579.31	8.55	570.76
	04-255	580.34	4.64	575.7	BCSP	08-126	579.23	7.58	571.65
TCLF	05-105	579.55	3.69	575.86		08-127	580.51	5.78	574.73
	05-107	576.54	5.28	571.26		08-128	580.29	7.45	572.84
	05-130	577.48	4.76	572.72		08-129	580.3	5.30	575
	05-132	575.11	2.98	572.13					

(1) - All depth to water and groundwater elevations measured from top of inner casing.
F - Water frozen at top of ground surface.
NI/P - Not installed as of this date/first (old) well plugged.
NI - Not installed as of this date.
CW - Clayton Wells (600 series) were locked and inaccessable to WESTON until June 1988.

Table 3-13
(continued)

Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 3/21/88	Water Level Elevation 3/21/88	Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 3/21/88	Water Level Elevation 3/21/88
SWLF	01-122	583.04	3.59	579.45	TCLF	05-134	5.91	572.8	572.49
	01-123	583.04	4.00	579.04		05-167	9.33	567.7	562.93
	01-124	585.72	3.63	582.09		05-231	6.24	571.25	568.85
	01-125	584.98	4.97	580.01		05-233	NI/P	570.26	NI/P
	01-156	584.71	3.87	580.84		05-235	5.80	574.26	574.23
	01-158	586.31	4.53	581.78		05-601	CW	CW	CW
	01-160	583.67	4.00	579.67		05-602	CW	CW	CW
	01-162	585.26	4.46	580.8		05-603	CW	CW	CW
	01-257	583.46	NI	NI		05-604	CW	CW	CW
	01-259	586.09	8.97	577.12		05-605	CW	CW	CW
	01-261	583.17	6.95	576.22		05-606	CW	CW	CW
	01-263	585.07	8.14	576.93	NWLF	06-108	5.36	583.88	583.28
FTA-2	02-164	580.42	3.63	576.79		06-109	F	F	F
	02-165	581.55	3.32	578.23		06-110	5.40	578.13	578.5
	02-166	581.89	5.30	576.59		06-144	4.23	583.47	582.38
FTA-1	03-116	579.89	2.44	577.45		06-146	4.71	579.27	578.2
	03-117	580.06	2.77	577.29		06-245	6.83	580.72	580.57
	03-118	580.64	2.90	577.74		06-247	5.48	578.06	578.29
WRMP	04-111	578.41	1.70	576.71	ERMP	07-102	4.95	573.25	573.62
	04-112	581.12	2.95	578.17		07-103	5.60	571.12	570.93
	04-113	581.07	F	F		07-104	5.37	572.52	572.24
	04-115	582.24	4.46	577.78		07-136	7.32	570.29	570.59
	04-148	582.08	7.38	574.7		07-138	6.11	570.55	568.78
	04-150	581.71	4.45	577.26		07-140	5.45	572.78	570.23
	04-152	582.00	7.94	574.06		07-142	4.20	574.95	576.02
	04-154	580.87	2.61	578.26		07-237	7.33	570.98	570.87
	04-249	581.54	3.91	577.63		07-239	5.17	571.2	571.76
	04-251	581.12	5.07	576.05		07-241	9.67	568.67	567.52
	04-253	582.15	6.45	575.7		07-243	8.20	571.11	570.76
	04-255	580.34	4.68	575.66	BCSP	08-126	6.92	572.31	571.65
TCLF	05-105	579.55	3.35	576.2		08-127	5.42	575.09	574.73
	05-107	576.54	5.50	571.04		08-128	6.65	573.64	572.84
	05-130	577.48	4.19	573.29		08-129	4.67	575.63	575
	05-132	575.11	F	F					

(1) - All depth to water and groundwater elevations measured from top of inner casing.
F - Water frozen at top of ground surface.
NI/P - Not installed as of this date/first (old) well plugged.
NI - Not installed as of this date.
CW - Clayton Wells (600 series) were locked and inaccessable to WESTON until June 1988.

Table 3-13
(continued)

Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 5/10/88	Water Level Elevation 5/10/88	Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 5/10/88	Water Level Elevation 5/10/88
SWLF	01-122	583.04	4.24	578.8	TCLF	05-134	578.71	6.54	572.17
	01-123	583.04	5.37	577.67		05-167	577.03	12.32	564.71
	01-124	585.72	3.90	581.82		05-231	577.49	17.46	560.03
	01-125	584.98	5.54	579.44		05-233	576.06	6.04	570.02
	01-156	584.71	5.65	579.06		05-235	580.06	5.80	574.26
	01-158	586.31	3.88	582.43		05-601	575.27	CW	CW
	01-160	583.67	4.55	579.12		05-602	575.06	CW	CW
	01-162	585.26	5.94	579.32		05-603	576.72	CW	CW
	01-257	583.46	9.30	574.16		05-604	575.93	CW	CW
	01-259	586.09	9.25	576.84		05-605	575.9	CW	CW
	01-261	583.17	6.93	576.24		05-606	577.77	CW	CW
	01-263	585.07	7.91	577.16	NWLF	06-108	589.24	6.41	582.83
FTA-2	02-164	580.42	5.02	575.4		06-109	583.81	2.47	581.34
	02-165	581.55	4.68	576.87		06-110	583.53	4.89	578.64
	02-166	581.89	4.88	577.01		06-144	587.70	5.79	581.91
FTA-1	03-116	579.89	3.17	576.72		06-146	583.98	6.09	577.89
	03-117	580.06	3.31	576.75		06-245	587.55	6.82	580.73
	03-118	580.64	3.35	577.29		06-247	583.54	4.96	578.58
WRMP	04-111	578.41	2.11	576.3	ERMP	07-102	578.20	6.67	571.53
	04-112	581.12	4.51	576.61		07-103	576.72	6.22	570.5
	04-113	581.07	5.15	575.92		07-104	577.89	5.76	572.13
	04-115	582.24	4.52	577.72		07-136	577.61	7.84	569.77
	04-148	582.08	6.03	576.05		07-138	576.66	7.52	569.14
	04-150	581.71	5.57	576.14		07-140	578.23	8.48	569.75
	04-152	582.00	9.47	572.53		07-142	579.15	7.08	572.07
	04-154	580.87	3.98	576.89		07-237	578.31	6.54	571.77
	04-249	581.54	4.33	577.21		07-239	576.37	6.25	570.12
	04-251	581.12	5.11	576.01		07-241	578.34	7.89	570.45
	04-253	582.15	6.33	575.82		07-243	579.31	7.32	571.99
	04-255	580.34	4.56	575.78	BCSP	08-126	579.23	8.89	570.34
TCLF	05-105	579.55	3.94	575.61		08-127	580.51	6.58	573.93
	05-107	576.54	5.80	570.74		08-128	580.29	7.71	572.58
	05-130	577.48	5.71	571.77		08-129	580.3	5.23	575.07
	05-132	575.11	4.71	570.4					

(1) - All depth to water and groundwater elevations measured from top of inner casing.
F - Water frozen at top of ground surface.
NI/P - Not installed as of this date/first (old) well plugged.
NI - Not installed as of this date.
CW - Clayton Wells (600 series) were locked and inaccessable to WESTON until June 1988.

Table 3-13
(continued)

Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 5/17/88	Water Level Elevation 5/17/88	Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 5/17/88	Water Level Elevation 5/17/88
SWLF	01-122	583.04	578.8	4.67	TCLF	05-134	578.71	572.17	6.48
	01-123	583.04	577.67	5.54		05-167	577.03	564.71	10.84
	01-124	585.72	581.82	4.25		05-231	577.49	560.03	12.48
	01-125	584.98	579.44	5.94		05-233	576.06	570.02	6.00
	01-156	584.71	579.06	6.96		05-235	580.06	574.26	5.90
	01-158	586.31	582.43	4.15		05-601	575.27	CW	CW
	01-160	583.67	579.12	4.77		05-602	575.06	CW	CW
	01-162	585.26	579.32	6.34		05-603	576.72	CW	CW
	01-257	583.46	574.16	8.34		05-604	575.93	CW	CW
	01-259	586.09	576.84	6.00		05-605	575.9	CW	CW
	01-261	583.17	576.24	6.81		05-606	577.77	CW	CW
	01-263	585.07	577.16	7.71	NWLF	06-108	589.24	582.83	6.69
FTA-2	02-164	580.42	575.4	5.38		06-109	583.81	581.34	2.65
	02-165	581.55	576.87	4.78		06-110	583.53	578.64	4.97
	02-166	581.89	577.01	5.18		06-144	587.70	581.91	6.07
FTA-1	03-116	579.89	576.72	3.01		06-146	583.98	577.89	6.34
	03-117	580.06	576.75	3.41		06-245	587.55	580.73	6.96
	03-118	580.64	577.29	3.61		06-247	583.54	578.58	5.14
WRMP	04-111	578.41	576.3	2.25	ERMP	07-102	578.20	571.53	6.95
	04-112	581.12	576.61	4.58		07-103	576.72	570.5	6.22
	04-113	581.07	575.92	4.95		07-104	577.89	572.13	5.67
	04-115	582.24	577.72	4.70		07-136	577.61	569.77	7.84
	04-148	582.08	576.05	6.02		07-138	576.66	569.14	6.64
	04-150	581.71	576.14	5.86		07-140	578.23	569.75	7.89
	04-152	582.00	572.53	8.67		07-142	579.15	572.07	7.45
	04-154	580.87	576.89	4.00		07-237	578.31	571.77	6.59
	04-249	581.54	577.21	4.57		07-239	576.37	570.12	6.17
	04-251	581.12	576.01	5.12		07-241	578.34	570.45	7.87
	04-253	582.15	575.82	6.50		07-243	579.31	571.99	7.08
	04-255	580.34	575.78	4.58	BCSP	08-126	579.23	570.34	8.42
TCLF	05-105	579.55	575.61	3.91		08-127	580.51	573.93	6.58
	05-107	576.54	570.74	5.81		08-128	580.29	572.58	7.48
	05-130	577.48	571.77	6.06		08-129	580.3	575.07	5.37
	05-132	575.11	570.4	4.70					

(1) - All depth to water and groundwater elevations measured from top of inner casing.
F - Water frozen at top of ground surface.
NI/P - Not installed as of this date/first (old) well plugged.
NI - Not installed as of this date.
CW - Clayton Wells (600 series) were locked and inaccessable to WESTON until June 1988.

Table 3-13
(continued)

Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 6/20/88	Water Level Elevation 6/20/88	Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 6/20/88	Water Level Elevation 6/20/88
SWLF	01-122	583.04	7.00	576.04	TCLF	05-134	578.71	7.62	571.09
	01-123	583.04	8.18	574.86		05-167	577.03	8.35	568.68
	01-124	585.72	5.31	580.41		05-231	577.49	6.39	571.1
	01-125	584.98	7.20	577.78		05-233	576.06	6.11	569.95
	01-156	584.71	9.07	575.64		05-235	580.06	6.15	573.91
	01-158	586.31	4.24	582.07		05-601	575.27	5.78	569.49
	01-160	583.67	8.35	575.32		05-602	575.06	5.71	569.35
	01-162	585.26	9.15	576.11		05-603	576.72	5.84	570.88
	01-257	583.46	7.52	575.94		05-604	575.93	4.30	571.63
	01-259	586.09	8.95	577.14		05-605	575.9	5.22	570.68
	01-261	583.17	6.67	576.5		05-606	577.77	3.77	574
	01-263	585.07	8.11	576.96	NWLF	06-108	589.24	7.87	581.37
FTA-2	02-164	580.42	8.30	572.12		06-109	583.81	5.09	578.72
	02-165	581.55	9.85	571.7		06-110	583.53	4.91	578.62
	02-166	581.89	9.75	572.14		06-144	587.70	7.60	580.1
FTA-1	03-116	579.89	7.35	572.54		06-146	583.98	7.06	576.92
	03-117	580.06	7.89	572.17		06-245	587.55	7.34	580.21
	03-118	580.64	8.09	572.55		06-247	583.54	4.91	578.63
WRMP	04-111	578.41	2.88	575.53	ERMP	07-102	578.20	7.73	570.47
	04-112	581.12	5.58	575.54		07-103	576.72	6.41	570.31
	04-113	581.07	4.88	576.19		07-104	577.89	7.64	570.25
	04-115	582.24	5.16	577.08		07-136	577.61	8.47	569.14
	04-148	582.08	6.35	575.73		07-138	576.66	7.20	569.46
	04-150	581.71	7.41	574.3		07-140	578.23	7.89	570.34
	04-152	582.00	8.11	573.89		07-142	579.15	8.04	571.11
	04-154	580.87	5.25	575.62		07-237	578.31	6.82	571.49
	04-249	581.54	4.97	576.57		07-239	576.37	5.81	570.56
	04-251	581.12	5.14	575.98		07-241	578.34	7.40	570.94
	04-253	582.15	6.65	575.5		07-243	579.31	7.26	572.05
	04-255	580.34	4.69	575.65	BSCP	08-126	579.23	9.00	570.23
TCLF	05-105	579.55	4.51	575.04		08-127	580.51	7.58	572.93
	05-107	576.54	6.08	570.46		08-128	580.29	7.73	572.56
	05-130	577.48	7.10	570.38		08-129	580.3	5.62	574.68
	05-132	575.11	6.11	569					

(1) - All depth to water and groundwater elevations measured from top of inner casing.
F - Water frozen at top of ground surface.
NI/P - Not installed as of this date/first (old) well plugged.
NI - Not installed as of this date.
CW - Clayton Wells (600 series) were locked and inaccessable to WESTON until June 1988.

Table 3-13
(continued)

Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 8/1/88	Water Level Elevation 8/1/88	Location	Well Number	Elevation Top Inner Casing	Depth To Water(1) 8/1/88	Water Level Elevation 8/1/88
SWLF	01-122	583.04	8.4	574.64	TCLF	05-134	578.71	7.83	570.88
	01-123	583.04	10	573.04		05-167	577.03	8.89	568.14
	01-124	585.72	5.8	579.92		05-231	577.49	9.13	568.36
	01-125	584.98	8.45	576.53		05-233	576.06	6.3	569.76
	01-156	584.71	10.65	574.06		05-235	580.06	6.33	573.73
	01-158	586.31	4.62	581.69		05-601	575.27	7.88	567.39
	01-160	583.67	10.7	572.97		05-602	575.06	7.1	567.96
	01-162	585.26	11.15	574.11		05-603	576.72	6.21	570.51
	01-257	583.46	7.85	575.61		05-604	575.93	4.5	571.43
	01-259	586.09	8.65	577.44		05-605	575.9	5.52	570.38
	01-261	583.17	7.4	575.77		05-606	577.77	4.1	573.67
	01-263	585.07	8.4	576.67	NWLF	06-108	589.24	5.96	583.28
FTA-2	02-164	580.42	13.67	566.75		06-109	583.81	5.6	578.21
	02-165	581.55	14.88	566.67		06-110	583.53	5.05	578.48
	02-166	581.89	13.46	568.43		06-144	587.70	8.51	579.19
FTA-1	03-116	579.89	7	572.89		06-146	583.98	7.59	576.39
	03-117	580.06	8.47	571.59		06-245	587.55	7.6	579.95
	03-118	580.64	8.84	571.8		06-247	583.54	5.03	578.51
WRMP	04-111	578.41	2.5	575.91	ERMP	07-102	578.20	8	570.2
	04-112	581.12	5.54	575.58		07-103	576.72	6.7	570.02
	04-113	581.07	5.5	575.57		07-104	577.89	5.65	572.24
	04-115	582.24	5.29	576.95		07-136	577.61	8.63	568.98
	04-148	582.08	6.87	575.21		07-138	576.66	7.5	569.16
	04-150	581.71	8.38	573.33		07-140	578.23	7.82	570.41
	04-152	582.00	6.82	575.18		07-142	579.15	8.58	570.57
	04-154	580.87	5.5	575.37		07-237	578.31	7.31	571
	04-249	581.54	5.06	576.48		07-239	576.37	5.82	570.55
	04-251	581.12	5.19	575.93		07-241	578.34	7.21	571.13
	04-253	582.15	6.65	575.5		07-243	579.31	7.36	571.95
	04-255	580.34	4.45	575.89	BCSP	08-126	579.23	9.06	570.17
TCLF	05-105	579.55	4.55	575		08-127	580.51	7.27	573.24
	05-107	576.54	6.52	570.02		08-128	580.29	7.35	572.94
	05-130	577.48	7.86	569.62		08-129	580.3	5.66	574.64
	05-132	575.11	7.27	567.84					

(1) - All depth to water and groundwater elevations measured from top of inner casing.
F - Water frozen at top of ground surface.
NI/P - Not installed as of this date/first (old) well plugged.
NI - Not installed as of this date.
CW - Clayton Wells (600 series) were locked and inaccessable to WESTON until June 1988.

The surveyed well locations were tied to the IRPIMS coordinate system and entered into a digitized base map of Selfridge ANGB prepared by Woolpert Consultants of Dayton, Ohio, and modified by WESTON-NCI of Seattle, Washington, a wholly owned subsidiary of WESTON.

3.5.2 Continuous Recorder Stations

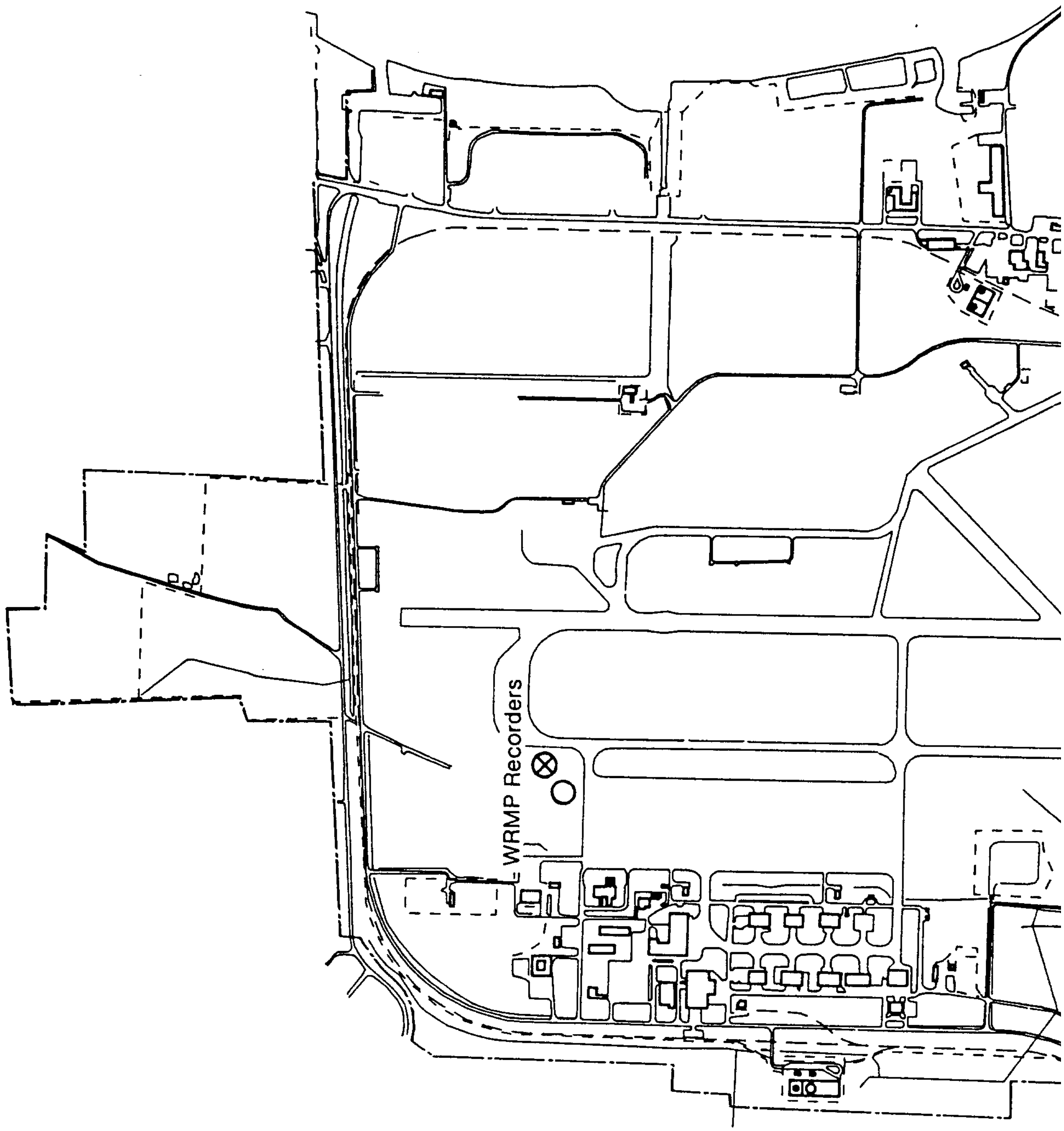
In accordance with Subsection 2.3 of the approved QAPP, six continuous water level recording stations were installed at three sites at Selfridge ANGB. The purpose of the recorder stations was to collect paired water level measurements in monitor wells and nearby stormwater manholes continuously for a 12-week period. Precipitation data for the same 12-week period were obtained from the base weather station. Comparisons could then be made between groundwater and surface water levels to determine the interrelationship of precipitation, surface water, the Selfridge ANGB stormwater sewer system, and groundwater levels and flow in the local hydrologic system.

The recorders were placed at three sites, with two recorders at each site. At each site a recorder was installed in a monitor well and in a nearby stormwater inlet. Locations at WRMP, ERMP, and FTA-2 were selected for the recorders as they represented equidistant points on the base and they were located at major stormwater inlets. The locations are shown in Figure 3-11.

The continuous water level recorders used were Leopold & Stevens Type F Model 68 recorders. Each recorder was equipped with a quartz multispeed timer powered by six dry cell batteries. Timer setting rates varied between 0.5 and 32 days; a setting of 32 days was chosen for this study in most cases. Settings of 1 day and 1 week were used several times to provide detailed "snapshots" of the water level information.

Gridded chart paper attached to a rotating drum records the trace of the plotting pen as the water level changes with respect to time. The timer is used to control the rate at which the inking pen moves across the chart paper. Water level changes are measured using a float and counterweight attached to a line or beaded cable. The line is wrapped around a pulley affixed to the chart paper drum.

Each continuous water level recorder was installed at the three monitor well sites in a similar manner. A plywood platform with cover box was first constructed. An access hole was cut into the plywood platform and positioned directly over the well. The platform was then bolted to the three bumper posts, which were positioned in a triangular pattern around the well. The distance between the top of the well and the platform varied between 1.0 and 2.5 feet. Figure 3-12 depicts a typical continuous water level recorder installation at a monitor well.


WRMP Recorders

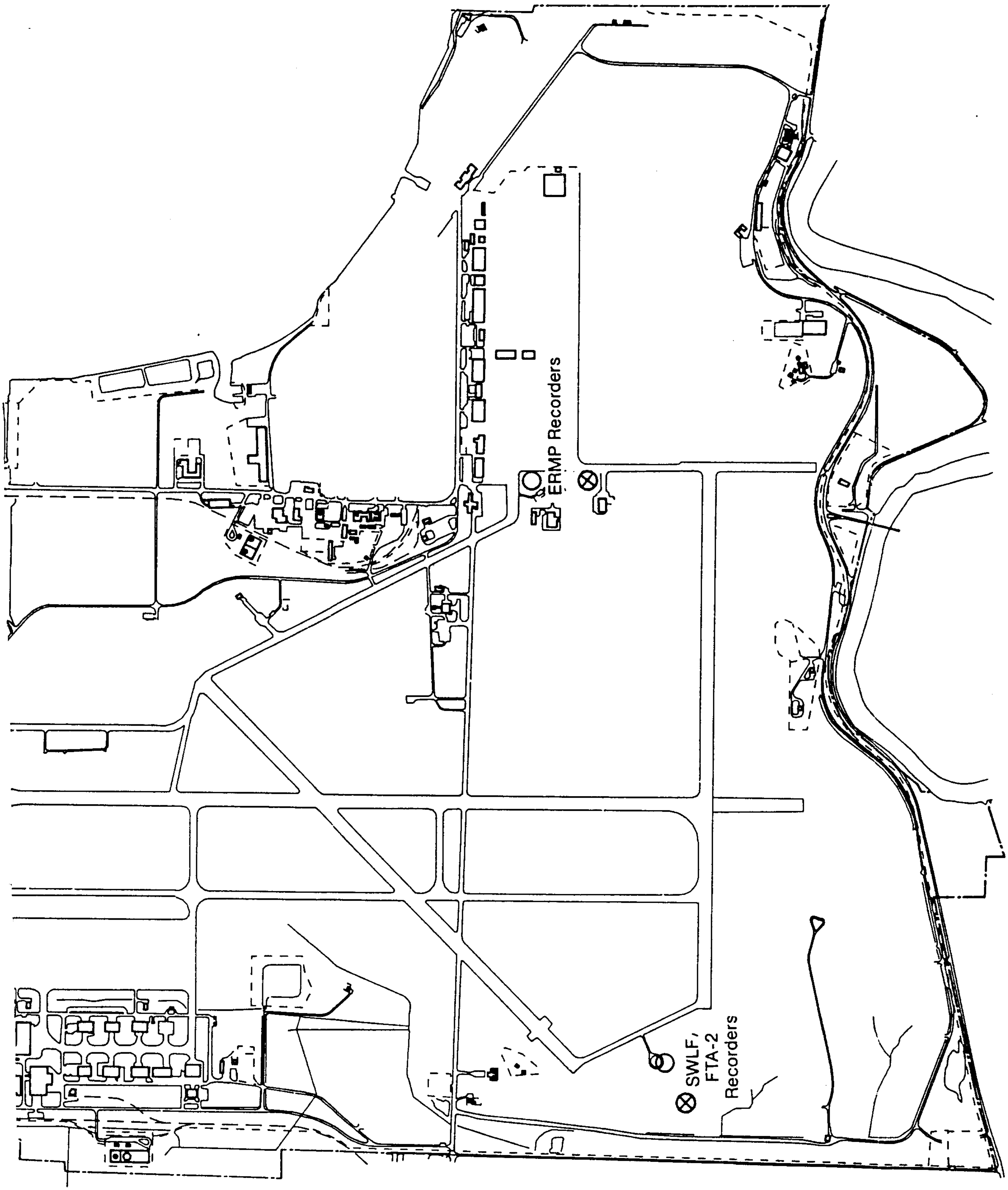


FIGURE 3-11

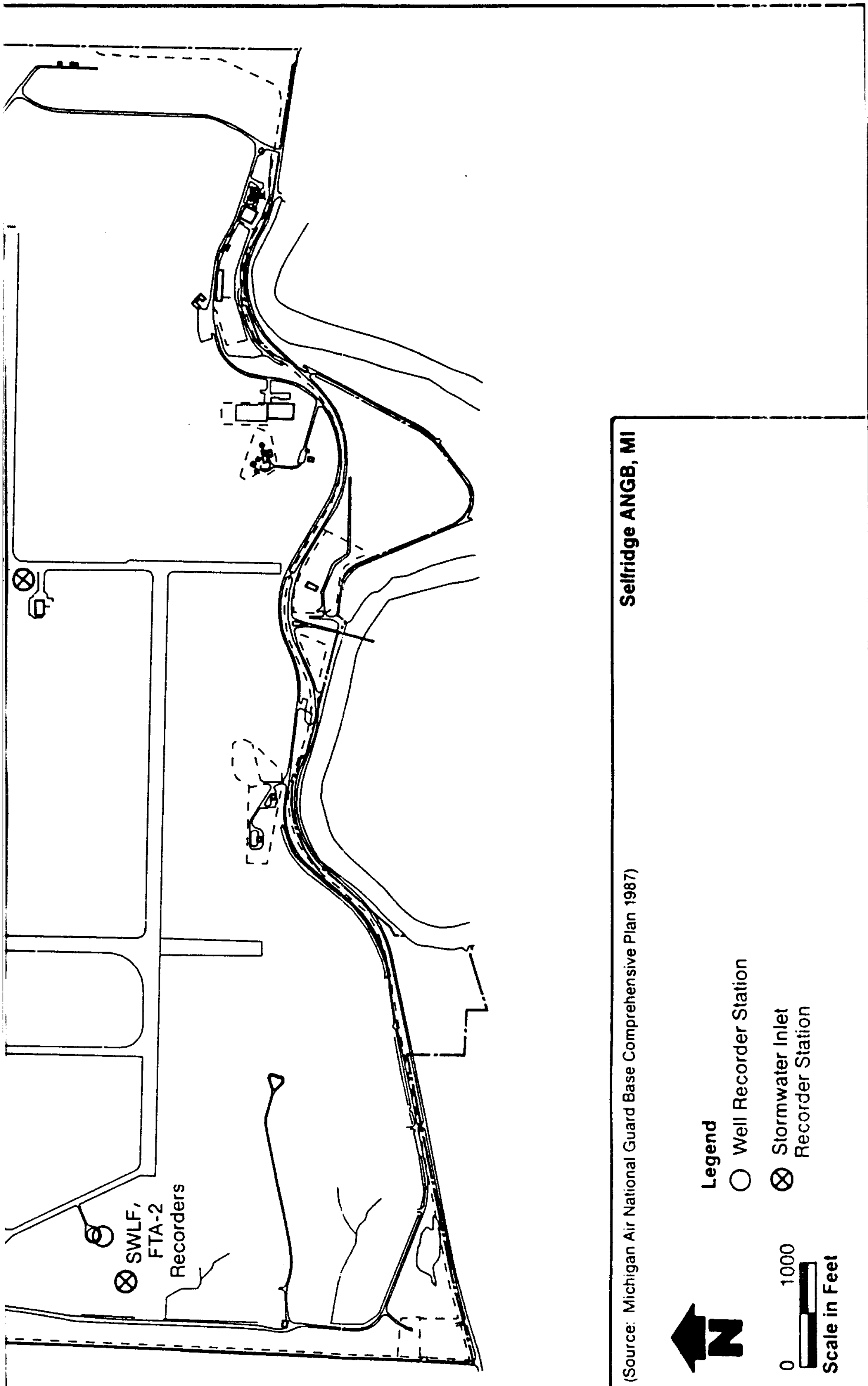


FIGURE 3-11 LOCATIONS OF CONTINUOUS WATER LEVEL RECORDER STATIONS, SELFRIDGE ANGB

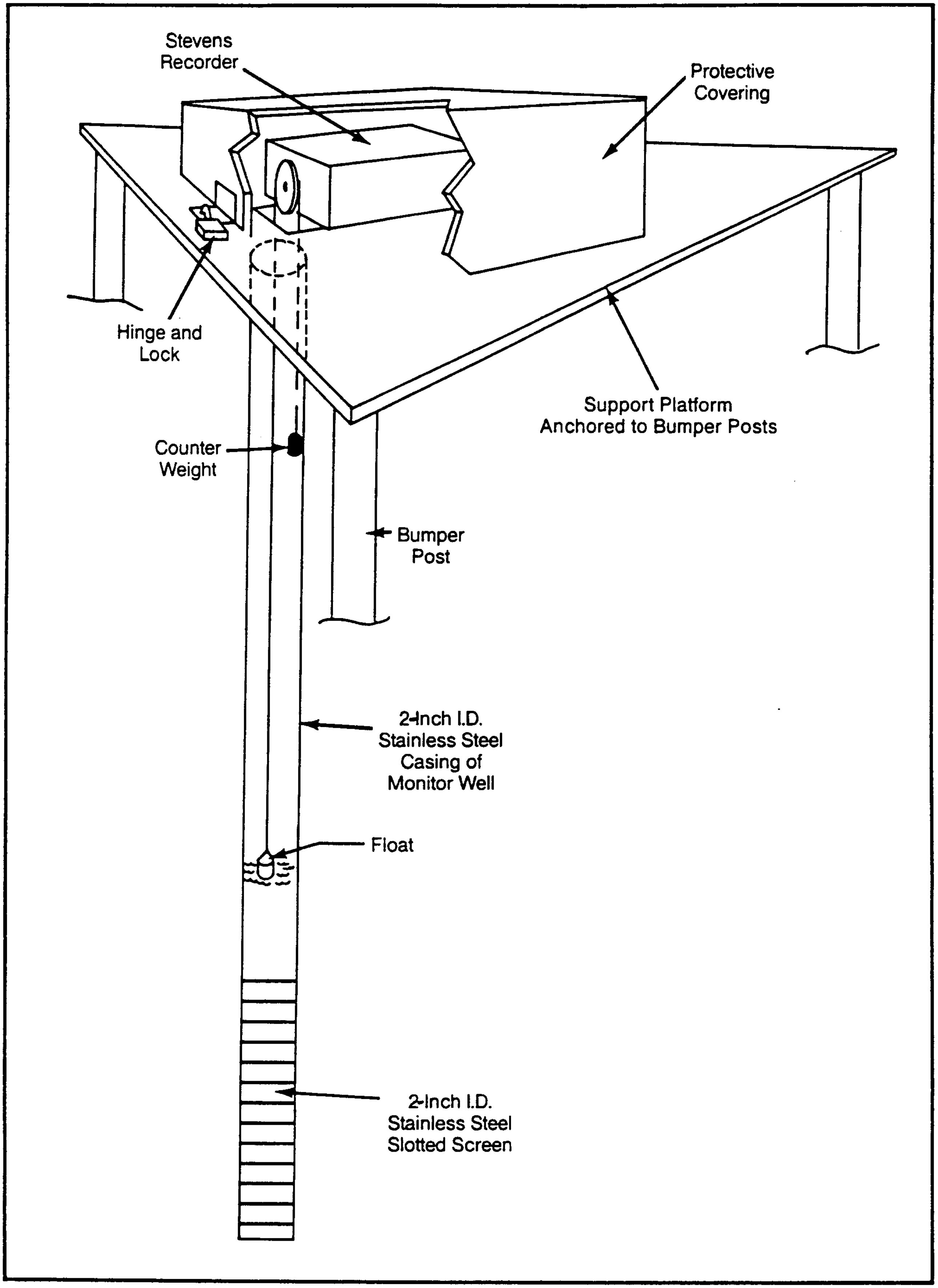


FIGURE 3-12 TYPICAL CONTINUOUS WATER LEVEL RECORDER AT A WELL INSTALLATION, SELFRIDGE ANGB

The cover box was hinged to the platform so that it could be lifted out of place for recorder maintenance. The box protected the recorder from the weather and buffeting winds due to local airplane traffic. A hasp and lock are used to secure the cover box over the recorder to prevent unauthorized access to the instrument.

The float and counterweight were suspended through the access hole down into the well. Fishing line served as the cable connecting the float and weight to the recorder pulley. Fishing line was used instead of a braided wire cable with metal beads because of the possibility that the metal beads would catch on the welded joints of the stainless steel casing.

A water level measurement was taken prior to installing the float and counterweight in the well. This information was recorded in the field logbook and on the chart paper on the drum. Date, time the recorder was started, recorder station number, direction on the chart paper corresponding to a rise in water level, pulley ratio, and starting point of the recorder pen were also recorded.

Three continuous water level recorder stations were set up at stormwater inlets. A construction and installation design was used similar to the one at the monitor well recorder stations. A stilling pipe or well was substituted for the well casing. Figure 3-13 depicts a continuous water level recorder installation at a stormwater inlet.

The stilling well was constructed of PVC pipe with 0.5-inch holes drilled into the lower 6 feet. The PVC pipe was securely attached to a rigid steel brace, then lowered through the stormwater inlet to the bottom of the sewer. Water could then flow through the holes and seek a level equal to that outside the stilling well. The float and counterweight were suspended through the stilling well to measure changes in water level.

The PVC pipe and steel brace were fitted with a wooden collar near the top. This collar was set into the position formerly occupied by the stormwater inlet grating. A similar collar attached to the bottom of the plywood platform served as a support at the top of the stilling well. The intent of these collars was to support the stilling well and to maintain it in a vertical position.

The recorder platform and cover box were positioned over the stilling well. The platform was secured to two parallel wooden 2 x 4's. The 2 x 4 boards were bolted at each end to steel fence posts that had been driven into the ground. The recorder platform was leveled prior to installation of the continuous water level recorder.

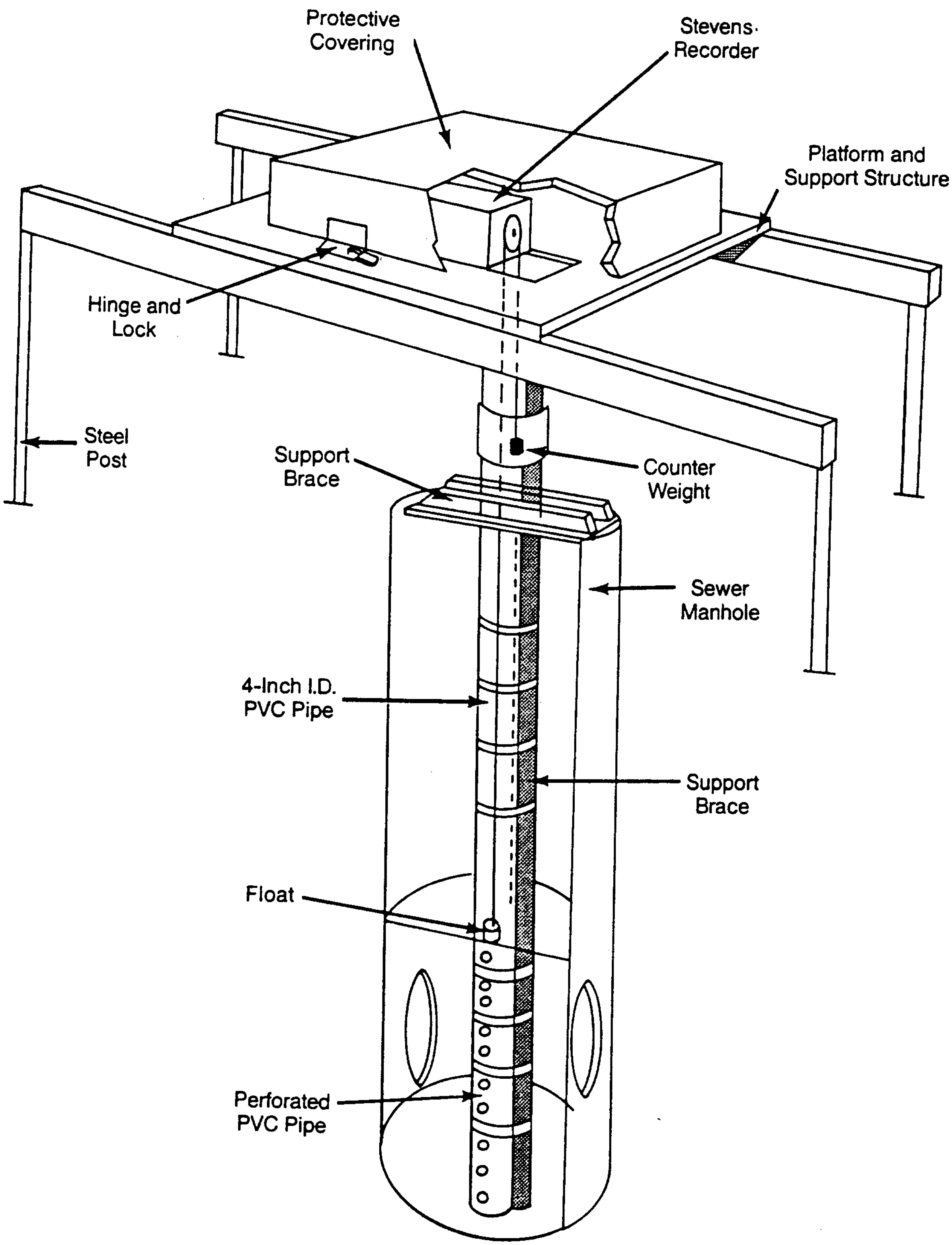


FIGURE 3-13 TYPICAL CONTINUOUS WATER LEVEL RECORDER AT A STORMWATER INLET, SELFRIDGE ANGB

Continuous water level recording was performed for a 12-week period. The length of the recording period was selected to allow sufficient time to determine base and site-specific groundwater fluctuation patterns. Because the recording period lasted from late winter to mid-spring, a determination was made concerning seasonal groundwater fluctuation patterns. The recorded seasonal changes are of use in making a generalization concerning the yearly pattern of groundwater level fluctuation.

The continuous water level charts collected during this investigation are reproduced in Appendix H. The data collected at each of these stations are summarized in Tables 3-14, 3-15 and 3-16.

3.5.3 Hydraulic Conductivity Testing

Hydraulic conductivity tests were performed on all existing and newly installed IRP groundwater monitor wells to assist in characterizing groundwater flow conditions at Selfridge ANGB. These tests were run immediately upon the completion of well development using the "rapid-evacuation slug test," also referred to in this report as a baildown recovery test. Consistent with Subsection 2.2.3 of the approved QAPP, the following procedure was used:

- Static water level was recorded.
- The well was completely evacuated of water using a decontaminated PVC bailer.
- Water level recovery measurements were obtained at predesignated time intervals.

The water level measurements were taken manually with an electric water level indicator or a fiber glass measuring tape with a "plopper" (a hollow device that produces a plopping sound on contact with the water surface). These devices were used instead of automated data collection equipment because the slow rate of recovery made automated data collection unnecessary and non-cost-effective. The water level measuring devices were decontaminated between uses as specified in Subsection 2.6.3 of the approved QAPP.

Hydraulic conductivities were calculated using methods described by Bouwer and Rice (1976). The equation is given in Appendix I, along with test graphs and calculation parameters for each of the wells tested. The results are summarized in Table 3-17.

WESTON

Table 3-14

Paired Continuous Water Level Data, FTA-2, IRP Stage 2, Selfridge ANGB, MI

Well 02-156		FTA-2 Storm Inlet Maximum Values		FTA-2 Storm Inlet Minimum Values	
Days	Elevation	Days	Elevation	Days	Elevation
2.67	575.73	4.88	562.33	4.88	561.96
3.67	575.85	5.88	562.29	5.88	561.94
4.67	575.97	6.21	562.31	6.21	561.98
5.67	575.79	6.71	563.52	6.71	563.23
6.67	575.95	6.88	562.93	6.88	562.58
7.01	576.15	7.00	562.53	7.00	562.23
7.67	576.55	7.38	562.41	7.38	562.02
8.67	576.53	7.63	562.48	7.63	562.11
9.67	576.35	7.88	562.43	7.88	562.01
10.67	576.33	8.21	562.38	8.21	561.98
11.67	576.10	9.00	562.36	9.00	562.01
12.67	576.05	10.00	562.36	10.00	562.01
13.67	576.05	11.00	562.34	11.00	561.99
14.67	575.88	12.00	562.33	12.00	561.98
15.67	576.00	13.00	562.35	13.00	562.02
16.67	576.20	13.38	562.33	13.38	561.98
17.67	576.27	14.00	562.36	14.00	562.03
18.34	576.24	15.00	562.35	15.00	562.01
19.68	576.28	15.54	562.44	15.29	561.86
20.68	576.28	15.71	562.46	15.54	562.08
21.34	576.40	15.88	562.38	15.71	562.07
22.01	576.80	16.00	562.36	15.88	562.02
23.00	------	17.00	562.33	16.00	562.05
24.00	------	18.00	562.31	17.00	562.02
25.00	------	19.00	562.33	18.00	561.96
26.00	------	20.00	562.33	19.00	561.99
27.00	------	20.43	562.31	20.00	562.00
28.00	------	21.00	562.33	20.43	561.98
29.00	------	21.60	562.36	21.00	562.01
30.00	------	21.93	562.42	21.60	562.01
31.00	------	22.93	562.36	21.93	562.00
32.00	------	23.93	562.33	22.93	561.91
33.00	------	24.93	562.36	23.93	561.98
34.00	------	25.26	562.33	24.93	562.00

-- No data collected

Table 3-14
(continued)

Well 02-165		FTA-2 Storm Inlet Maximum Values		FTA-2 Storm Inlet Minimum Values	
Days	Elevation	Days	Elevation	Days	Elevation
35.66	578.23	25.43	562.36	25.26	561.98
36.00	578.34	25.76	562.48	25.43	562.01
37.00	578.30	26.26	562.38	25.76	562.11
38.00	578.34	26.91	562.37	26.26	562.03
39.00	578.49	27.00	562.36	26.91	562.03
40.00	578.58	28.00	562.35	27.00	561.98
41.00	578.61	29.00	562.32	28.00	562.02
42.00	578.49	30.00	562.28	29.00	561.98
43.00	578.45	31.00	562.32	30.00	561.95
43.34	578.25	31.66	562.34	31.00	561.99
44.34	578.25	32.00	562.33	31.66	562.03
45.34	578.10	33.00	562.32	32.00	561.98
46.34	578.05	34.00	562.28	33.00	562.01
47.34	578.00	35.00	562.29	34.00	561.98
48.34	578.08	36.00	562.29	35.00	561.99
49.34	578.50	37.00	562.29	36.00	561.95
50.34	578.49	38.43	562.33	37.00	561.96
51.34	578.48	39.00	562.32	38.43	562.00
52.00	------	39.79	562.28	39.00	561.99
53.00	------	40.00	562.24	39.79	561.98
54.00	------	41.00	562.24	40.00	561.96
55.79	576.49	42.00	562.26	41.00	561.91
56.79	576.49	43.00	562.26	42.00	561.98
57.79	576.41	44.00	562.25	43.00	561.96
58.79	576.30	45.00	562.23	44.00	561.98
59.79	576.20	46.00	562.22	45.00	561.97
60.79	576.15	47.00	562.26	46.00	561.96
61.79	576.09	48.00	562.34	47.00	561.98
62.79	576.00	49.00	562.28	48.00	562.02
63.79	575.91	50.00	562.27	49.00	561.99
64.79	575.89	50.71	562.26	50.00	561.98
65.79	575.86	50.86	563.18	50.71	561.98
66.79	575.86	51.08	562.98	50.86	562.78
67.79	575.75	51.21	562.72	51.04	562.73
68.79	575.75	51.38	562.51	51.21	562.33
69.79	575.68	52.00	562.34	51.38	562.23
70.79	575.68	52.71	562.28	52.00	561.99

-- No data collected

Table 3-14
(continued)

Well 02-165		FTA-2 Storm Inlet Maximum Values		FTA-2 Storm Inlet Minimum Values	
Days	Elevation	Days	Elevation	Days	Elevation
71.50	575.68	53.42	562.26	52.71	561.90
72.17	575.68	54.83	562.28	53.42	562.23
73.17	575.67	55.83	562.33	54.83	561.93
74.17	575.60	56.71	562.29	55.83	562.03
75.17	575.48	57.00	562.31	56.71	561.98
76.17	575.48	58.00	562.33	57.00	562.01
77.17	575.45	59.00	562.29	58.00	562.02
78.17	575.35	60.00	562.30	59.00	561.98
79.17	575.30	61.00	562.28	60.00	562.01
80.17	575.24	62.00	562.34	61.00	561.98
81.17	575.20	63.00	562.30	62.00	562.03
82.17	575.15	64.00	562.28	63.00	562.01
83.17	575.02	65.00	562.33	64.00	561.98
84.17	574.92	66.00	562.28	65.00	562.03
85.17	574.86	67.00	562.31	66.00	562.02
86.17	574.86	68.00	562.32	67.00	562.03
87.17	574.86	69.00	562.28	68.00	561.98
88.17	574.88	70.00	562.31	69.00	561.95
89.17	574.85	71.00	562.28	70.00	562.01
90.17	574.85	72.00	562.33	71.00	562.00
90.50	574.65	73.00	562.29	72.00	562.03
91.17	574.63	74.00	562.26	73.00	562.01
92.17	574.60	75.00	562.25	74.00	562.15
93.18	574.55	76.00	562.24	75.00	561.68
94.17	574.70	77.00	562.23	76.00	561.68
		78.00	562.24	77.00	561.68
		79.00	562.24	78.00	561.68
		80.00	562.23	79.00	561.68
		81.00	562.23	80.00	561.68
		82.00	562.24	81.00	561.63
		83.00	562.28	82.00	561.63
		84.00	562.29	83.00	561.68
		85.00	562.28	84.00	562.03
		86.00	562.26	85.00	561.73
		87.00	562.28	86.00	561.71
		88.00	562.26	87.00	561.72
		89.00	562.24	88.00	561.68
		90.00	562.32	89.00	561.68
		91.00	562.28	90.00	562.18
				91.00	561.93

-- No data collected

Table 3-15

Paired Continuous Water Level Data, WRMP,
IRP Stage 2, Selfridge ANGB, MI

Well 04-150		West Ramp Storm Inlet		Well 04-150		West Ramp Storm Inlet	
Days	Elevation	Days	Elevation	Days	Elevation	Days	Elevation
2.64	571.66	4.51	567.47	43.38	575.51	28.00	567.21
3.00	571.78	4.58	567.84	44.38	576.01	29.00	567.21
4.00	572.19	4.68	567.24	45.38	576.76	30.00	567.21
5.00	572.51	5.18	567.17	46.38	577.64	31.00	567.21
6.00	572.84	6.51	567.18	47.38	578.81	32.75	567.20
7.00	573.15	6.68	568.26	48.00	---	33.00	567.20
8.00	573.42	6.85	567.87	49.38	580.11	34.00	567.20
9.00	573.69	7.18	567.20	50.38	580.46	35.00	567.20
10.00	573.98	7.63	567.30	51.38	580.56	36.00	567.20
11.00	---	7.85	567.20	52.38	580.76	37.00	567.20
12.00	---	8.00	567.20	53.38	580.79	38.00	567.20
13.00	---	9.51	567.20	54.38	580.79	39.00	567.20
14.00	---	10.00	567.20	55.00	---	40.00	567.20
15.00	---	11.00	567.20	56.00	---	41.00	567.20
16.00	---	12.51	567.21	57.50	568.86	42.00	567.20
17.72	575.46	13.00	567.21	58.00	---	43.00	567.20
18.05	575.51	14.00	567.21	59.00	---	44.00	567.20
19.05	575.62	15.51	567.20	60.00	---	45.00	567.20
20.05	575.79	15.64	567.47	61.00	---	46.55	567.20
21.05	575.76	15.85	567.20	62.00	---	46.89	567.38
22.05	575.94	16.00	567.20	63.00	---	46.93	567.20
23.05	576.02	17.51	567.20	64.00	---	47.26	567.42
24.05	576.10	18.08	567.22	65.00	---	47.55	567.22
25.05	576.29	19.71	567.22	66.00	---	47.76	567.95
26.05	576.46	19.75	567.30	67.00	---	47.89	567.27
27.05	576.59	19.83	567.22	68.50	576.11	48.89	567.24
28.05	576.69	20.42	567.21	69.00	576.22	50.55	567.24
29.05	576.78	20.75	567.29	70.00	576.37	50.72	567.24
30.05	576.81	20.83	567.21	71.00	576.45	50.89	569.44
31.05	576.87	21.42	567.21	72.00	576.53	51.22	567.77
32.00	---	21.75	567.31	73.00	576.51	52.22	567.27
33.00	---	21.92	567.22	74.00	576.53	53.55	567.23
34.71	577.26	22.00	567.22	75.00	576.54	54.00	567.23
35.71	577.33	23.00	567.22	76.00	576.53	55.00	567.23
36.71	577.46	24.08	567.22	77.00	576.49	56.00	567.23
37.71	577.43	25.42	567.22	78.00	576.45	57.00	567.23
38.71	577.49	25.50	567.72	79.00	576.41	58.00	567.23
39.63	577.51	25.58	567.55	80.00	576.36	59.00	567.23
40.00	---	25.75	567.47	81.00	576.29	60.00	567.23
41.00	---	26.08	567.21	82.00	576.22	61.00	567.23
42.38	574.76	27.00	567.21	83.00	576.21	62.22	567.22

--- No data collected

Table 3-15
(continued)

Well 04-150		West Ramp Storm Inlet	
Days	Elevation	Days	Elevation
84.00	576.19	62.89	568.02
85.00	576.14	63.22	567.25
86.00	576.05	64.22	567.22
87.00	576.04	65.00	567.22
88.00	576.00	66.00	567.22
89.00	575.93	67.00	567.22
90.00	575.95	68.00	567.22
91.00	575.92	69.00	567.22
92.00	---	70.00	567.22
		71.00	567.22
		72.00	567.22
		73.42	567.31
		73.46	567.26
		74.00	567.26
		75.79	567.22
		76.00	567.22
		77.00	567.22
		78.00	567.22
		79.00	567.22
		80.00	567.22
		81.00	567.22
		82.00	567.22
		83.00	567.22
		84.46	567.22
		84.75	567.82
		84.79	567.22
		85.00	567.22
		86.00	567.22
		87.00	567.22
		88.00	567.22
		89.00	567.22
		90.79	567.22
		90.92	568.47
		91.13	567.24
		92.46	567.23

--- No data collected

Table 3-16

Paired Continuous Water Level Data, ERMP, IRP Stage 2, Selfridge ANGB, MI

Well 07-140		East Ramp Storm Inlet		Well 07-140		East Ramp Storm Inlet	
Days	Elevation	Days	Elevation	Days	Elevation	Days	Elevation
1.52	567.14	3.73	564.53	42.52	572.83	26.71	564.40
2.52	567.53	4.06	564.33	43.52	572.75	27.38	564.35
3.52	567.98	4.39	565.21	44.52	572.70	27.54	564.50
4.52	568.28	4.56	564.55	45.52	572.65	27.71	564.35
5.52	568.48	4.73	564.38	46.52	572.52	28.38	564.30
6.52	568.78	5.06	564.28	47.52	572.47	28.54	564.41
7.52	568.98	5.73	564.25	48.52	572.55	28.71	564.30
8.52	569.18	6.39	564.35	49.52	572.65	29.71	564.28
9.52	569.33	6.56	565.40	50.52	572.77	30.71	564.30
10.52	569.53	6.73	565.25	51.52	572.90	31.38	564.55
11.52	569.71	7.06	564.69	52.52	573.00	32.04	564.30
12.52	569.83	7.48	564.75	53.52	573.02	33.04	564.30
13.52	569.96	7.73	564.55	54.52	573.02	34.38	564.25
14.52	570.05	8.06	564.45	55.52	572.98	35.38	564.23
15.52	570.20	8.39	564.40	56.52	572.89	36.38	564.23
16.52	570.33	9.06	564.35	57.52	572.77	37.38	564.25
17.52	570.43	10.39	564.25	58.52	572.65	38.38	564.45
18.52	570.50	11.39	564.22	59.52	572.50	39.38	564.35
19.52	570.65	12.39	564.20	60.52	572.35	40.71	564.30
20.52	570.75	13.39	564.20	61.52	572.35	41.38	564.28
21.52	570.90	13.73	564.25	62.52	572.26	41.71	564.80
22.52	571.45	14.39	564.30	63.52	572.18	42.38	564.35
23.52	571.75	15.06	564.25	64.52	---	43.38	564.35
24.52	571.75	15.39	564.30	65.52	---	44.38	564.33
25.52	571.75	15.56	564.50	66.52	---	45.38	564.33
26.52	571.75	15.73	564.45	67.52	---	46.38	564.48
27.52	571.75	16.06	564.35	68.52	565.77	46.71	564.28
28.52	571.75	16.39	564.30	69.52	566.14	46.92	565.30
29.52	571.75	17.39	564.25	70.52	566.72	47.04	564.40
30.52	571.75	17.71	564.25	71.52	567.08	47.33	564.78
31.52	571.75	18.71	564.25	72.52	567.43	47.71	564.45
32.52	571.75	19.71	564.30	73.52	567.76	47.79	565.61
33.52	571.75	20.71	564.35	74.52	568.02	48.04	564.68
34.52	571.75	21.38	564.30	75.52	568.28	48.71	564.50
35.52	572.68	22.38	564.40	76.52	568.55	49.71	564.40
36.52	572.75	23.38	564.35	77.52	568.72	50.38	564.38
37.52	572.81	24.71	564.33	78.52	568.91	50.79	565.75
38.52	572.92	25.21	565.03	79.52	569.09	51.04	565.15
39.52	572.98	25.38	564.70	80.52	569.29	51.38	564.85
40.52	572.93	25.71	564.65	81.52	569.42	51.71	564.68
41.52	572.82	26.04	564.50			52.38	564.53

--- No data collected

4194R

Table 3-16
(continued)

Well 07-140		East Ramp Storm Inlet	
Days	Elevation	Days	Elevation
82.52	569.53	53.04	564.45
83.52	569.70	54.04	564.38
84.52	569.79	55.71	564.28
85.52	569.92	56.71	564.27
86.52	569.99	57.71	564.25
87.52	570.08	58.38	564.45
88.52	570.15	58.71	564.25
89.52	570.24	59.71	564.25
90.52	570.33	60.71	564.23
		61.71	564.21
		61.92	565.48
		62.04	564.28
		62.71	564.23
		63.71	564.20
		64.71	564.20
		65.88	564.78
		66.04	564.25
		67.04	564.20
		68.04	564.17
		69.38	564.20
		76.38	564.08
		77.38	564.08
		78.38	564.08
		79.38	564.08
		80.38	564.08
		81.38	564.08
		82.38	564.05
		83.38	564.05
		84.38	564.10
		84.54	565.10
		84.71	564.13
		85.38	564.11
		86.38	564.08
		87.38	564.08
		88.38	564.08
		89.38	564.08
		90.38	564.08
		90.71	565.98
		91.04	564.23
		92.04	564.13

--- No data collected

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Table 3-17

Hydraulic Conductivity Values, IRP Stage 2, Selfridge ANGB, MI

Well Number	K (ft/s)	K (cm/s)	Well Number	K (ft/s)	K (cm/s)
01-122	2.90 E-05	8.85 E-04	05-105	1.79 E-06	5.47 E-05
01-123	4.18 E-07	1.27 E-05	05-107	5.38 E-07	1.64 E-05
01-124	1.27 E-06	3.88 E-05	05-130	2.53 E-06	7.71 E-05
01-125	3.99 E-07	1.21 E-05	05-231	1.64 E-07	5.00 E-06
01-156	9.07 E-07	2.76 E-05	05-132	8.48 E-07	2.58 E-06
01-257	2.56 E-07	7.82 E-06	05-233	1.12 E-07	3.42 E-06
01-158	** **	** **	05-134	4.02 E-07	1.22 E-05
01-259	4.46 E-07	4.46 E-07	05-235	7.77 E-07	2.36 E-05
01-160	6.42 E-07	1.95 E-05	05-167	3.89 E-07	1.18 E-05
01-261	2.38 E-07	7.25 E-06	06-108	4.48 E-07	1.36 E-05
01-162	1.27 E-06	3.87 E-05	06-109	1.10 E-06	3.37 E-05
01-263	5.65 E-08	1.72 E-06	06-110	9.15 E-06	2.79 E-04
02-164	1.95 E-06	5.95 E-05	06-144	3.42 E-06	1.04 E-04
02-165	7.47 E-07	2.27 E-05	06-245	2.87 E-07	8.76 E-06
02-166	5.02 E-07	1.53 E-05	06-146	2.89 E-06	8.81 E-05
03-116	8.64 E-05	2.63 E-03	06-247	6.05 E-06	1.84 E-04
03-117	3.97 E-05	1.21 E-03	07-102	9.89 E-07	3.01 E-05
03-118	3.51 E-06	1.07 E-04	07-103	9.67 E-07	2.95 E-05
04-111	8.55 E-07	2.60 E-05	07-104	1.50 E-06	4.58 E-05
04-112	1.03 E-06	3.14 E-05	07-136	3.64 E-05	1.11 E-03
04-113	2.92 E-07	8.92 E-06	07-237	9.35 E-07	2.85 E-05
04-115	2.44 E-06	7.45 E-05	07-138	1.04 E-06	3.18 E-05
04-148	1.54 E-06	4.70 E-05	07-239	6.13 E-07	1.87 E-05
04-249	3.60 E-07	1.10 E-05	07-140	9.05 E-07	2.76 E-05
04-150	4.99 E-07	1.52 E-05	07-241	8.66 E-07	2.64 E-05
04-251	4.66 E-07	1.42 E-05	07-142	4.54 E-06	1.38 E-04
04-152	7.54 E-07	2.29 E-05	07-243	1.77 E-06	5.40 E-05
04-253	5.86 E-07	1.78 E-05	08-126	1.32 E-06	4.03 E-05
04-154	1.75 E-06	5.34 E-05	08-127	2.16 E-06	6.59 E-05
04-255	4.44 E-07	1.35 E-05	08-128	7.35 E-07	2.24 E-05
			08-129	8.99 E-07	2.74 E-05

01 - Southwest Landfill
02 - Fire Training Area 2
03 - Fire Training Area 1
04 - West Ramp
05 - Tucker Creek Landfill
06 - Northwest Landfill
07 - East Ramp
08 - Base Coal Storage Pile

*** Rapid recharge to well 01-158 prevented collection of valid test data.

3.6 ENVIRONMENTAL SAMPLING

3.6.1 Soil Sampling

Ninety-three soil samples collected during the Stage 2 drilling program were submitted for chemical analyses. As described in Subsection 2.5.3 of the approved QAPP, 3 samples were retained for chemical analysis from each of the 29 soil borings, for a total of 87 samples. The other six samples were retained from deep groundwater monitor well borings at two sites, SWLF and NWLF, where no soil borings were drilled.

In accordance with Table 2-4 of the approved QAPP, the soil samples were analyzed for selected parameters depending on the IRP site at which they were collected. These parameters are listed in Table 3-18 of this report. Soil samples were selected for chemical analysis based on visual evidence, unusual odors suggestive of contamination, HNu photoionization or OVA readings, or suspicion of contamination at specific locations and/or depths.

A continuous sampler tube system or a split-spoon sampler was used to collect the soil samples as described in Subsection 3.4.1 of this report. Decontamination of drilling and sampling equipment was done in accordance with Subsection 2.6.1 of the approved QAPP prior to initiating drilling at each soil and well boring. All drilling equipment, including augers, continuous sampling tubes, and split-spoons, was steam cleaned on a concrete pad west of WRMP in an area specifically designated by base personnel for decontamination.

Soil cores were removed from the continuous sampling tubes or split-spoon samplers onto aluminum foil, where they were monitored with an OVA detector or HNu photoionization meter. Samples were taken from the soil cores with metal spatulas and were placed in clean glass containers.

The metal spatulas were decontaminated prior to each sampling event according to the following procedure:

- Washed with an Alconox solution.
- Rinsed with clean water.
- Sprayed with methanol.
- Sprayed with hexane.
- Rinsed with deionized water.
- The spatulas were allowed to air dry, then wrapped in aluminum foil until the next sampling event.

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Table 3-18

Analytical Parameters for Soils,
IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method
Petroleum hydrocarbons	SW3550/E418.1
Metals screen (23 metals)	SW3050/SW6010
Arsenic	SW3050/SW7060
Mercury	SW7471
Selenium	SW3050/SW7740
Volatile organic compounds	SW5030/SW8240
Extractable priority pollutants (BNAs)	SW3550/SW82790
EP toxicity	40 CFR 261.24
Soil moisture	ASTM D2216

Sampling documentation is contained in Appendix G, and sample chain-of-custody documentation is contained in Appendix K.

3.6.2 Groundwater Sampling

Groundwater samples were collected from 61 monitor wells at 8 different sites located around the base to provide information to determine more completely the types of contaminants and the extent of contamination. Table 3-19 lists the parameters for analyses. Of these 61 wells, 20 had been installed in the Phase II Stage 1 drilling program and 41 were installed in the IRP Stage 2 investigation.

In accordance with Subsection 2.5.1 of the approved QAPP, the static water volume in the well was calculated by measuring initial water level and depth to bottom. After checking for evidence of floating hydrocarbons on the water surface, decontaminated PVC bailers were used to purge the well until three well volumes had been removed or until the well went completely dry. This was done to ensure collecting representative samples. During purging, three measurements of pH, temperature, and specific conductance were recorded and checked for consistency.

Decontaminated teflon bailers were used to collect groundwater samples from monitor wells. Bailers were decontaminated prior to sampling each monitor well using a six-step process:

- Washed with an Alconox solution.
- Rinsed with clean water.
- Sprayed with methanol.
- Sprayed with hexane.
- Rinsed with deionized water.
- Bailers were allowed to air dry, then wrapped in aluminum foil until the next sampling event.

In many cases, the wells at Selfridge ANGB were very slow rechargers and had to be allowed two or more days of recharge before sampling. When this was the case, a water level would be taken before sampling to ensure that the well was still recharging and had not reached equilibrium. If a well had reached equilibrium, it was again purged to ensure collecting a representative sample. Sampling documentation is contained in Appendix J, and sample chain-of-custody documentation is contained in Appendix K.

Table 3-19

Analytical Parameters for Groundwater, IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method
Alkalinity (carbonate, bicarbonate, and hydroxide (in situ))	A4013
Nitrogen, ammonia	E530.3
Common anions (chloride, sulfate, orthophosphate)	A429
Nitrate/nitrite	E353.1
Fluoride	E340.2
Total organic carbon (TOC)	E415.1
Chemical oxygen demand (COD)	A508A
Specific conductance (field test)	E120.1
pH (field test)	E150.1
Temperature (field test)	E170.1
Total dissolved solids (TDS)	E160.1
ICP metals screen (23 metals)	E200.7
Arsenic	E206.2
Lead	E239.2
Mercury	E245.1
Selenium	E270.2
Petroleum hydrocarbon compounds	E418.1
Purgeable halocarbon compounds	E601
Acidity	E305.1
Extractable priority pollutants (BNAs)	E625
Purgeable aromatic compounds	SW5030/SW8020

3.6.3 Surface Water Sampling

Two rounds of surface water sampling were performed at Selfridge ANGB by WESTON personnel. Surface water samples were analyzed for the parameters listed in Table 3-20. The first round of samples was taken on 20 April 1988 after an extended dry period. The second round of samples was taken on 9 May 1988 after a period of rain. Surface water was collected from 24 sampling locations of which 5 are pond locations and 19 are stormwater system manholes. Location of each surface water collection point was recorded in field notebooks and marked on the field and project maps.

In accordance with Subsection 2.5.2 of the approved QAPP, pond samples were collected by submerging a clean bottle in the water to be sampled and then transferring that water to the sample bottles provided by the laboratory. Manhole station samples were collected with decontaminated steel buckets. Buckets were decontaminated using the same six-step procedure described in Subsection 3.6.2 of this report. Temperature, pH, and specific conductance were measured at each sampling point in the same manner as for groundwater samples.

Sampling documentation is contained in Appendix J, and sample chain-of-custody documentation is outlined in Appendix K.

3.6.3.1 Pond Sampling Locations

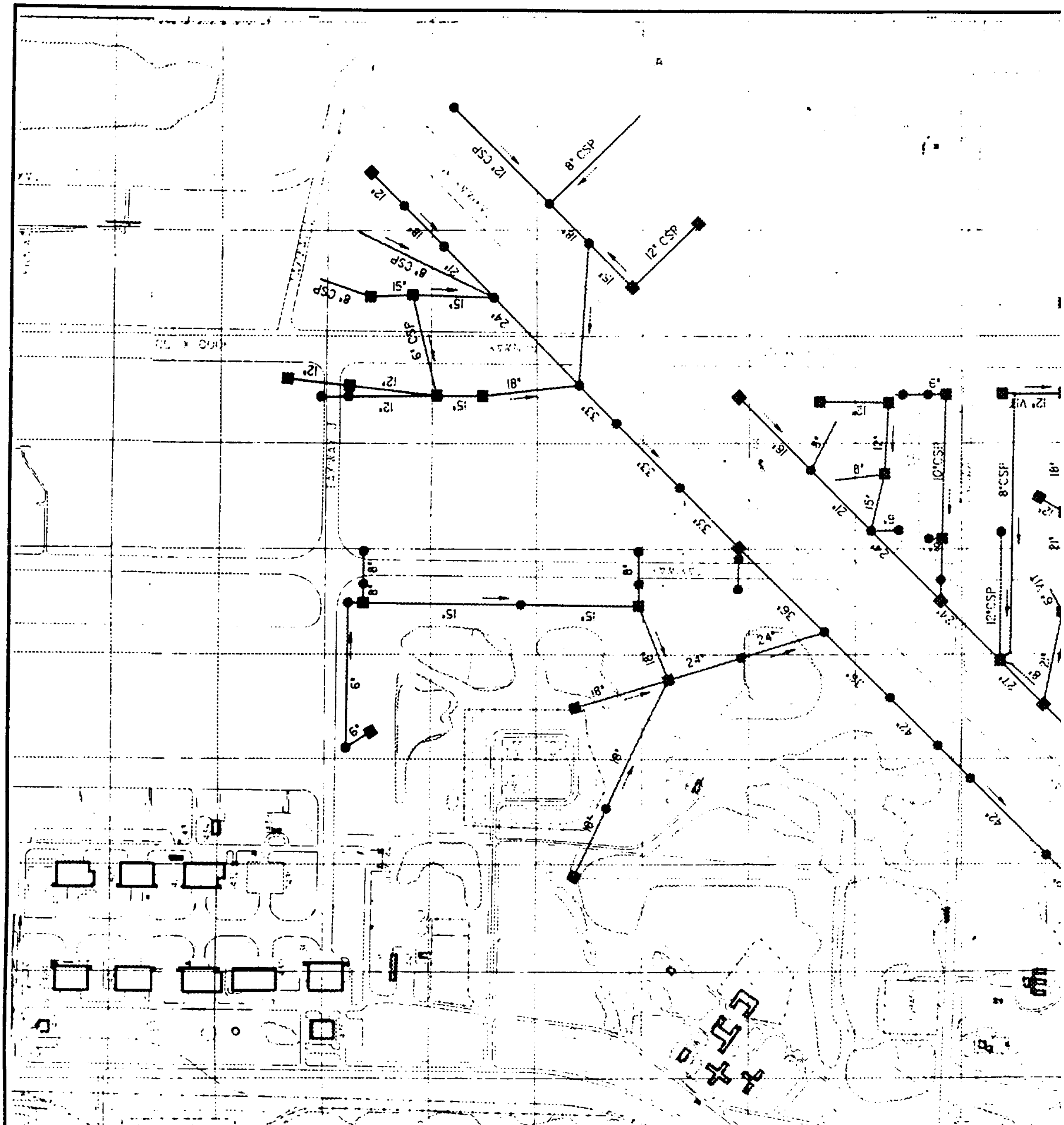
Surface water samples were taken from five surface depressions in which water ponds -- three at SWLF and two at FTA-2. The locations of these ponds are shown in Figure 3-14. The three pond locations at SWLF were also sampled during the Stage 1 study. Pond 1 has been designated 01-501 and is located at the center of the landfill. This pond is in direct contact with the active landfill. Pond 2 has been designated 01-502 and is located on the northwestern boundary of SWLF in a ditch along the perimeter road. Pond 3 has been designated 01-504 and is located in the southwestern corner of SWLF.

The two Stage 1 pond sampling locations at FTA-2 were renamed and relocated during the Stage 2 sampling events. Pond A has been changed to 02-506, and pond B has been changed to 02-507. Their locations were moved from inside the bermed area of FTA-2 to outside the bermed area. Pond 02-506 is now located southeast of the bermed area, and 02-507 is now located northeast of the bermed area near the FTA-2 entrance. Pond 02-506 is in a depression in the woods, and Pond 02-507 is part of a series of drainage depressions that receive drainage from the bermed area. These ponds were sampled rather than ponded water inside the bermed area to determine whether surface water draining from the burn pit area was contaminated.

Table 3-20

Analytical Parameters for Surface Water,
IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method
Alkalinity (carbonate, bicarbonate, and hydroxide (in situ))	A403
Nitrogen, ammonia	E530.3
Common anions (chloride, sulfate, orthophosphate)	A429
Nitrate/nitrite	E353.1
Fluoride	E340.2
Total organic carbon (TOC)	E415.1
Chemical oxygen demand (COD)	A508A
Specific conductance (field test)	E120.1
pH (field test)	E150.1
Temperature (field test)	E170.1
Total dissolved solids (TDS)	E160.1
ICP metals screen (23 metals)	E200.7
Arsenic	E206.2
Lead	E239.2
Mercury	E245.1
Selenium	E270.2
Petroleum hydrocarbon compounds	E418.1
Purgeable halocarbon compounds	E601
Acidity	E305.1
Extractable priority pollutants (BNAs)	E625
Purgeable aromatic compounds	SW5030/SW8020



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

24" Storm Sewer Main

Manhole

Catch Basin

Surface Water Pond

Directional Flow Arrow

SW01-501 Surface Water Sampling Location

0 500 1000

Scale in Feet

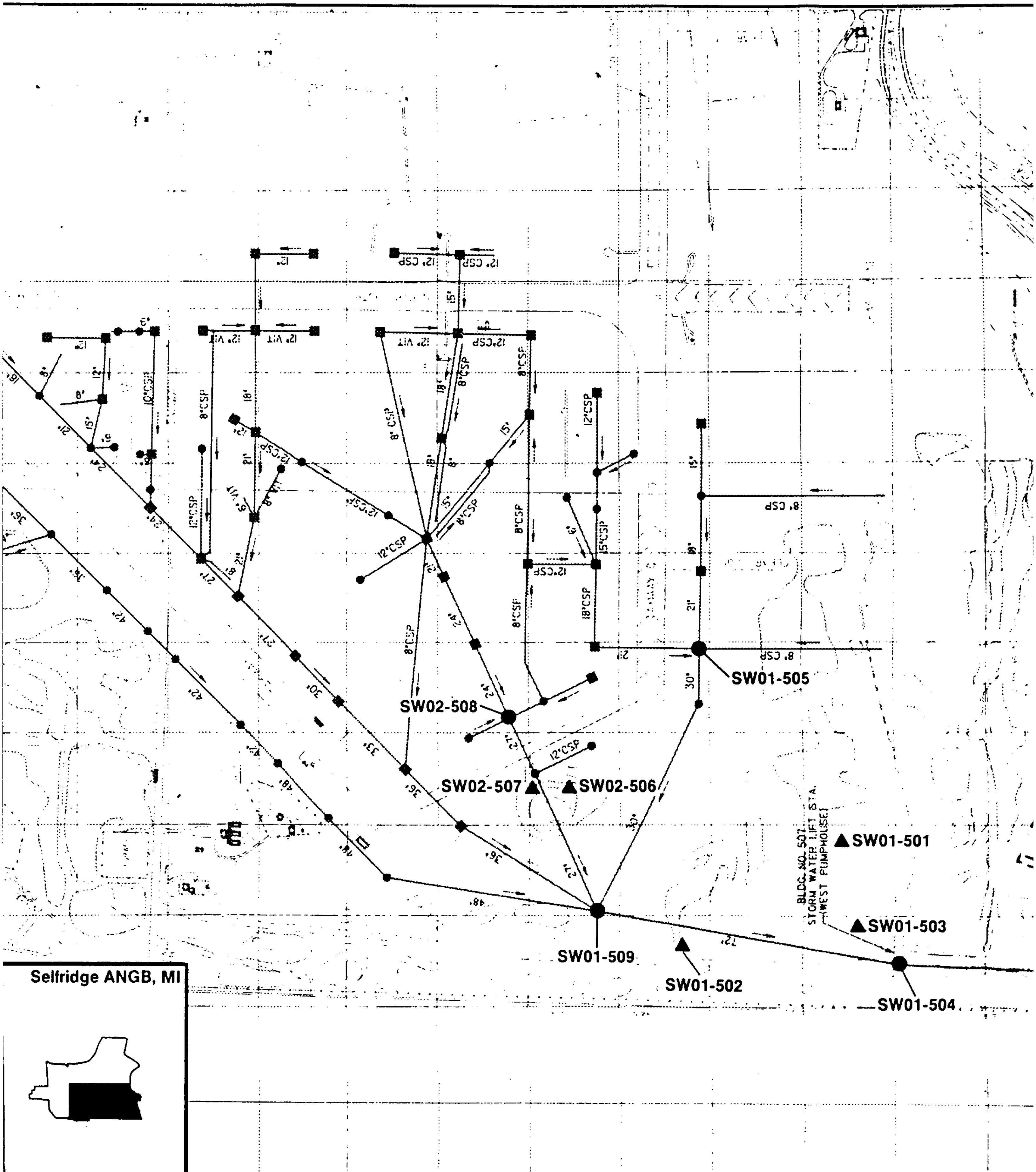


FIGURE 3-14 STOR SYSTE AREA

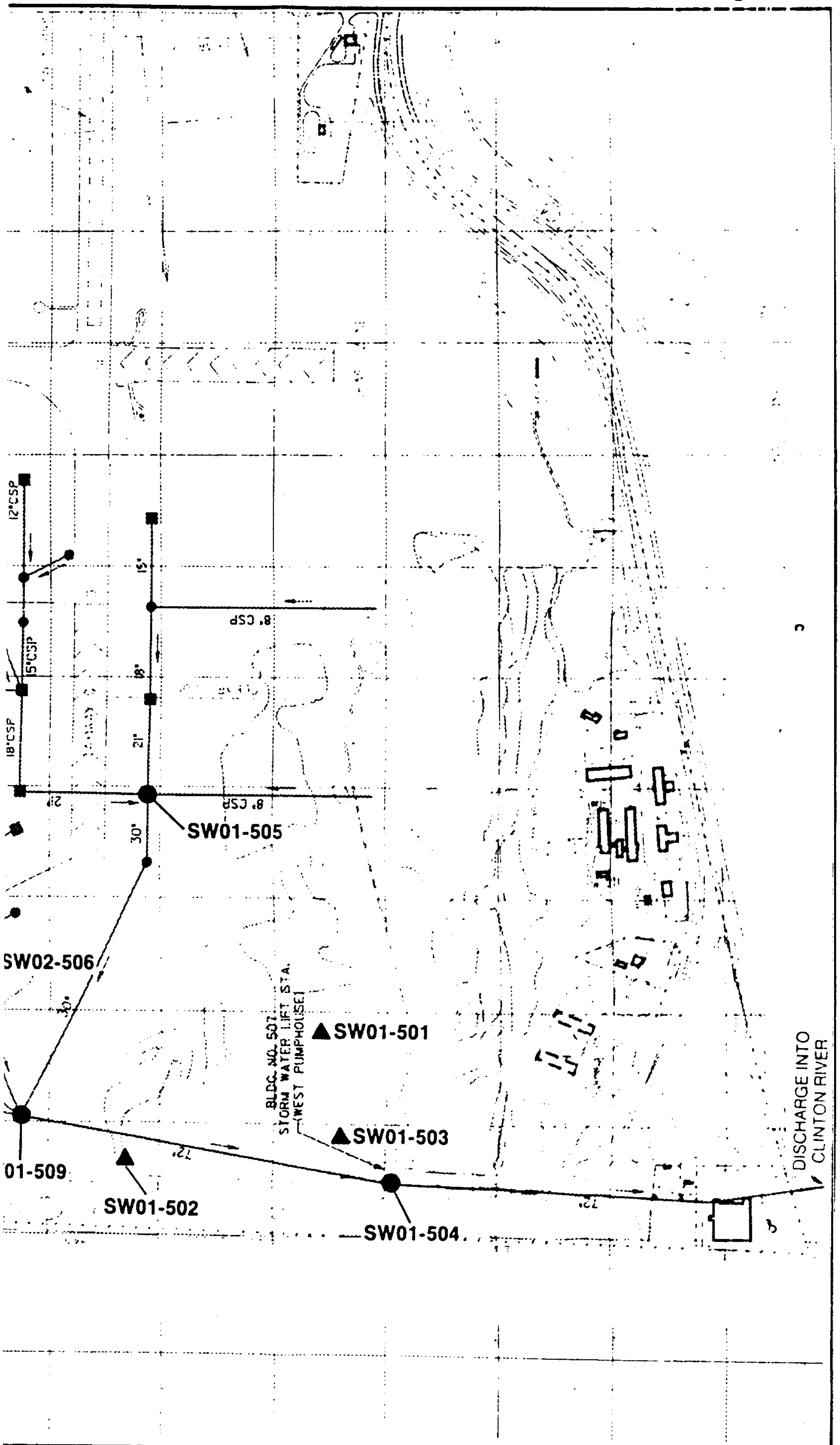


FIGURE 3-14 STORMWATER DRAINAGE SYSTEM IN THE FIRE TRAINING AREA 2 AND SOUTHWEST

3.6.3.2 Stormwater Sampling Locations

Selfridge ANGB is divided into four major drainage areas by the base stormwater sewer system. Surface water samples were collected from 19 manhole and catch basin locations along these stormwater drainage systems.

The first drainage area is comprised of SWLF and FTA-2 and is illustrated in Figure 3-14. Sampling location 02-508 will be considered background for this drainage area since it is the most upgradient sampling point. Sampling location 01-505 received drainage from the eastern side of SWLF. Location 02-509 is receiving water directly from FTA-2 and is downgradient of 01-505. Sampling location 01-504 is the last sampling point before this area's water is discharged into the Clinton River. This location is at a stormwater lift station that is downgradient of 02-508, 01-505, and 02-509.

The second drainage area takes water from WRMP, NWLF, and the Coast Guard area for discharge into Lake St. Clair (see Figure 3-15). This area contains six sampling locations. Sampling locations 04-510 and 04-511 receive water from the eastern side of WRMP, while 04-513 receives the runoff of the western side of the ramp. Sampling location 06-519 receives runoff from the Coast Guard area, and 06-520 gets the runoff from NWLF. The last sampling location in this drainage area is 04-512, which is the farthest downgradient sample taken before discharging into Lake St. Clair.

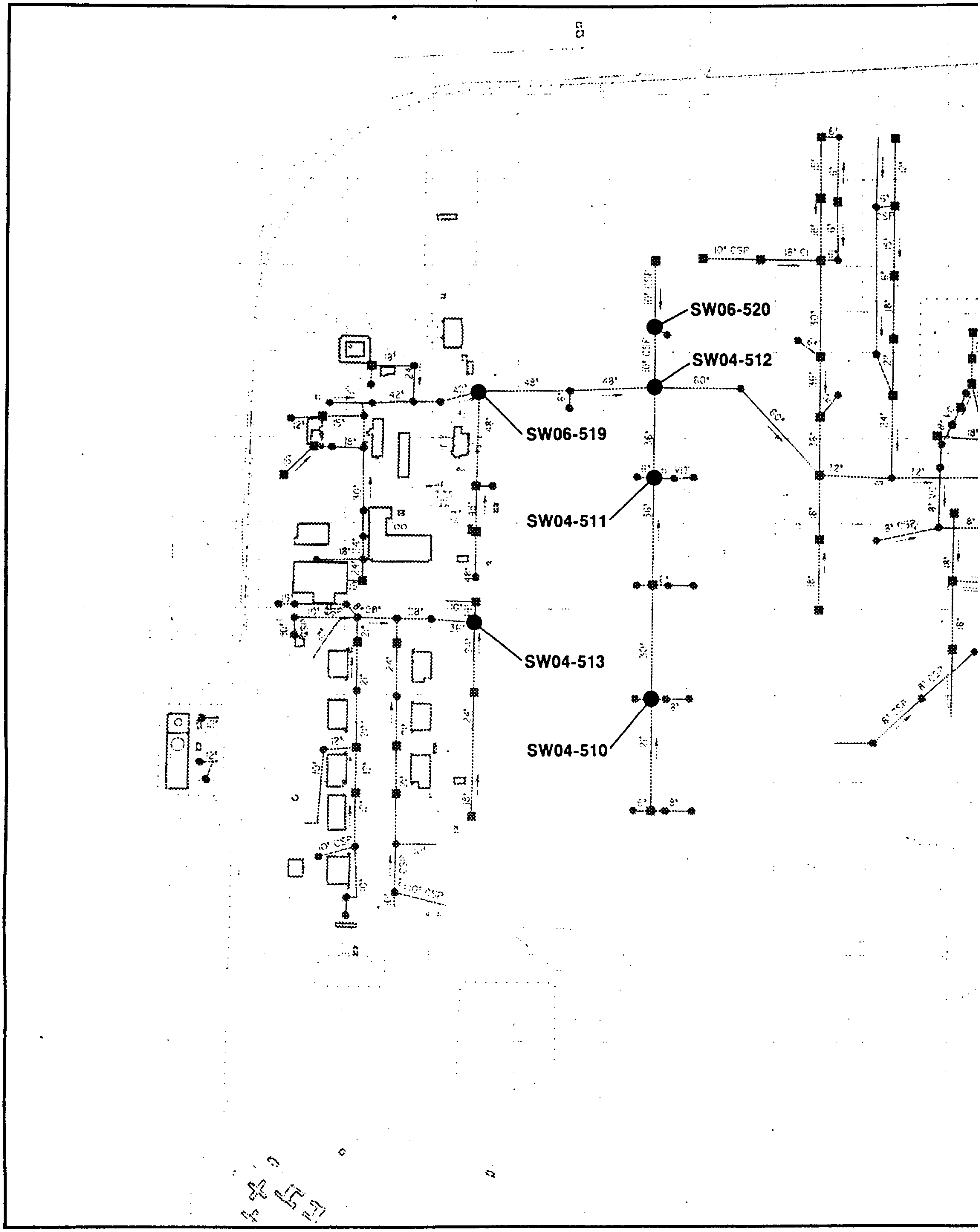
The third major area drains TCLF and discharges into Lake St. Clair (see Figure 3-16). This area contains five sampling locations. Location 05-515 is west of TCLF and is considered to be the background for that area. Sampling location 05-514 receives runoff water from the southern end of the drainage area. Sampling location 05-516 is downgradient of both 05-514 and 05-515. Location 05-517 receives water from the northern end of TCLF. Sampling point 05-518 is a lift station where all TCLF water goes before discharge into the lake.

The fourth major area drains ERMP and discharges to both Lake St. Clair (see Figure 3-17) and the Clinton River. This area has four sampling locations. Locations 07-521 and 07-522 receive water from the northern side of ERMP before discharging into the lake. Locations 07-524 and 07-523 receive water from the southern side of ERMP before discharging into the river.

3.6.4 Sample Handling

3.6.4.1 Sample Preservation Methods

The preservation reagents required for all analyses of groundwater and surface water were provided in the sample containers



SW06-520
SW04-512
SW06-519
SW04-511
SW04-513
SW04-510

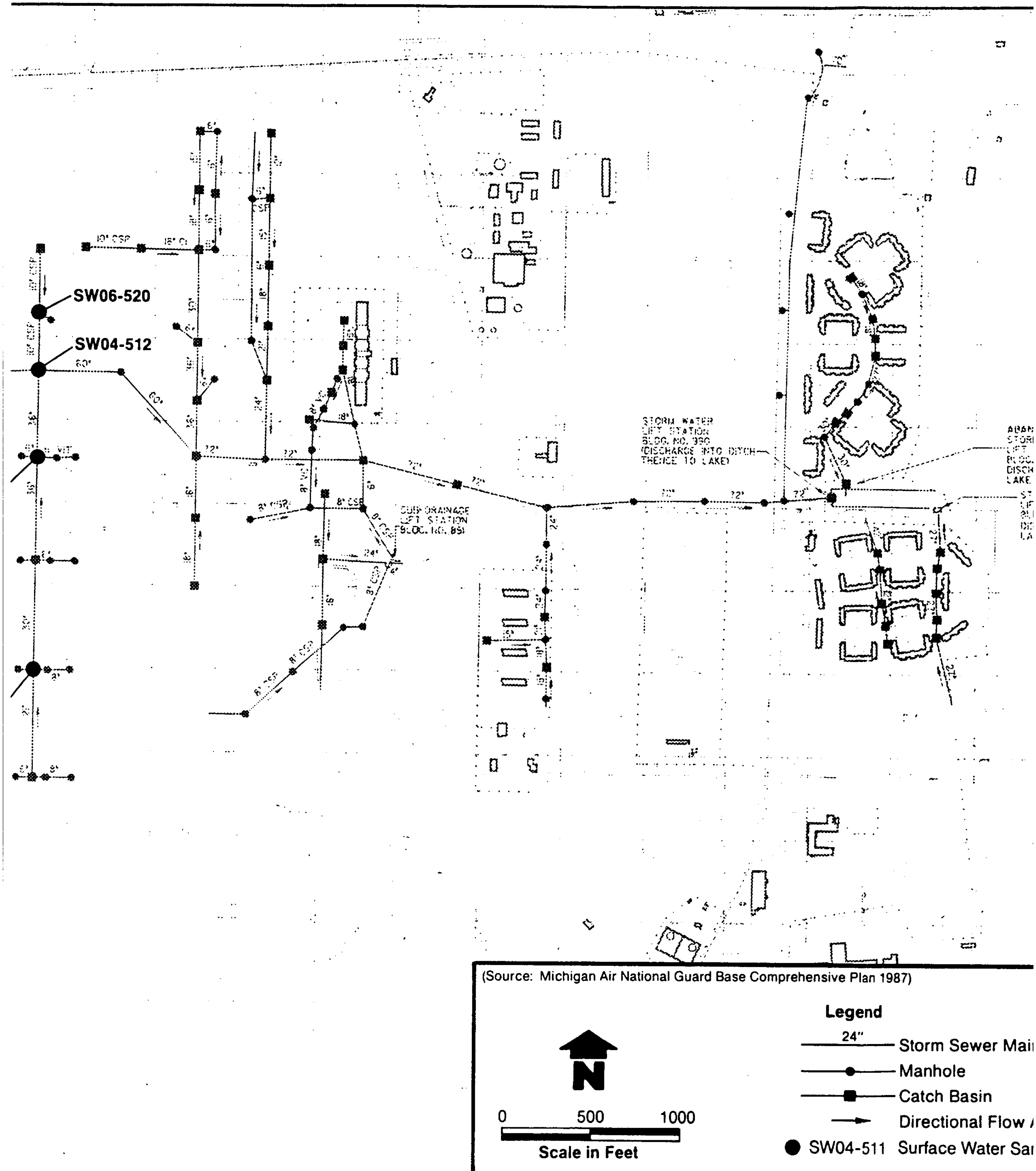
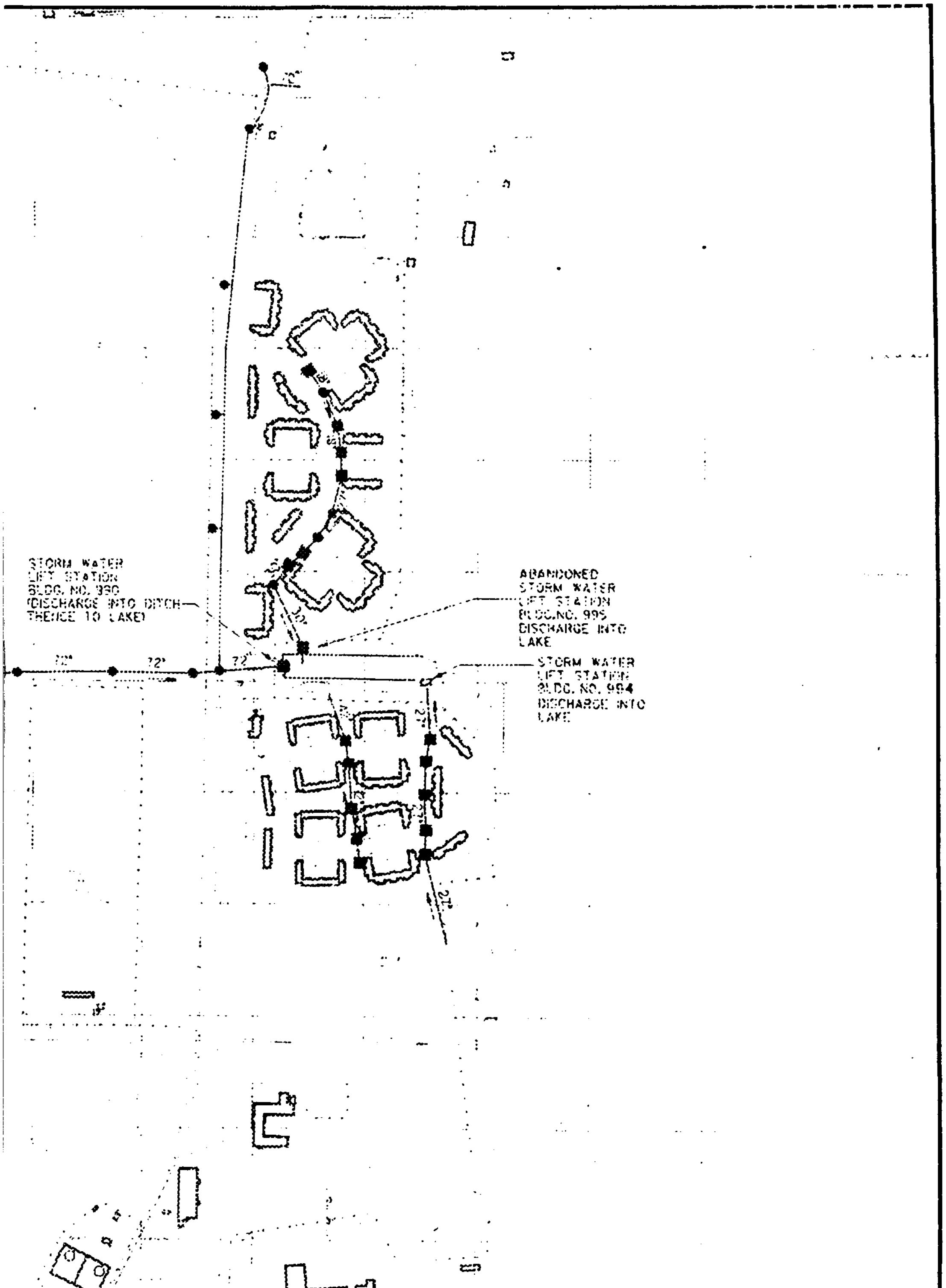


FIGURE 3-15 ST
SY
NC



National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

24" Storm Sewer Main

Manhole

Catch Basin

Directional Flow Arrow

SW04-511 Surface Water Sampling Location

1000

eet

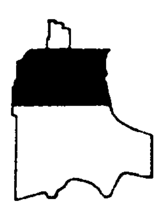


FIGURE 3-15 STORMWATER DRAINAGE SYSTEM IN THE WEST RAMP AND NORTHWEST LANDFILL AREA

WESTON

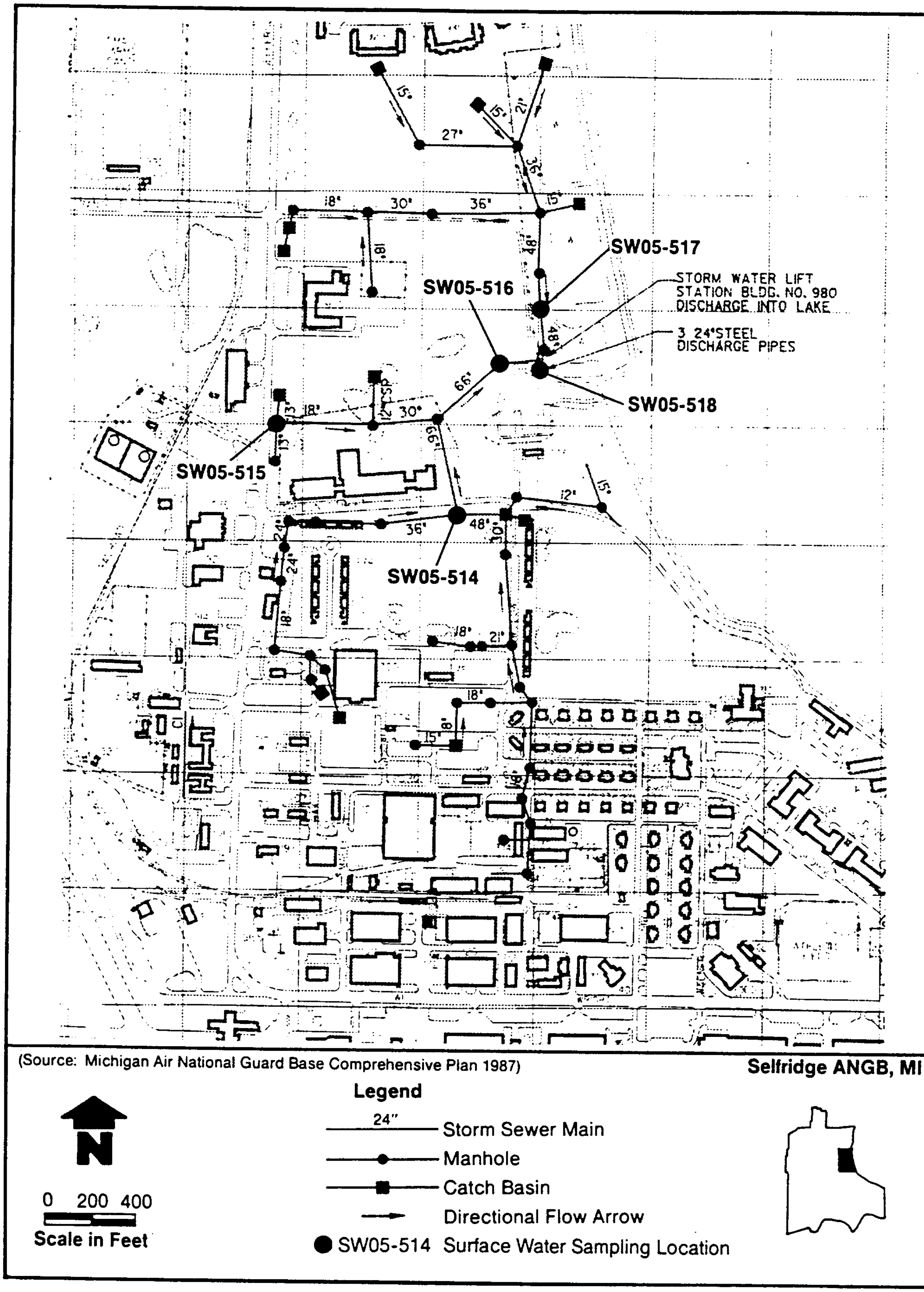
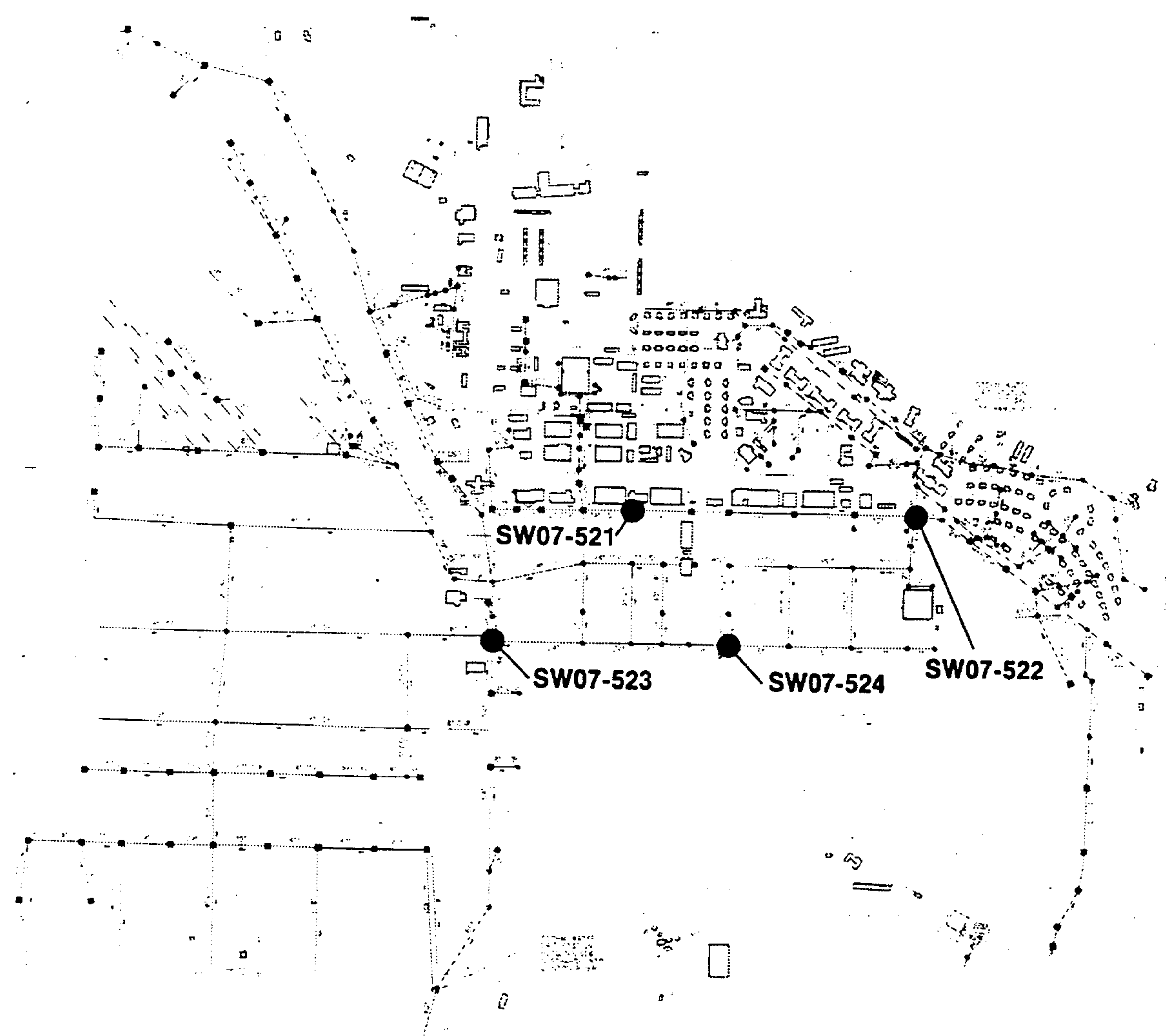


FIGURE 3-16 STORMWATER DRAINAGE SYSTEM IN THE TUCKER CREEK LANDFILL AREA



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

24" Storm Sewer Main
Manhole
Catch Basin
Directional Flow Arrow
SW07-521 Surface Water Sampling Location

N

0 500 1000
Scale in Feet

FIGURE 3-17 STORMWATER DRAINAGE SYSTEM IN THE EAST RAMP AREA

prepared by WESTON Analytics. The required preservation methods for target analyses specified in Subsection 2.7.2 of the approved QAPP are listed in Table 3-21 of this report. Preservation for all analyses was in accordance with that given in 40 CFR Part 136, No. 209, 26 October 1984. Soil samples were preserved using ice to keep the temperature down to 4°C, while groundwater and surface water samples for selected parameters required preservation with acid to achieve a pH less than 2.0. As specified in Subsection 2.5.1 of the approved QAPP, water samples to be analyzed for metals were filtered with a 0.45-micron filter before transferring to the sample containers with the proper preservation reagents. Ice was used to cool all samples to 4°C, following sample collection and during shipment to the laboratory to ensure adequate preservation.

3.6.4.2 Required Containers and Holding Times

The types of sample containers provided for the different parameters are specified in Subsection 2.7.1 of the approved QAPP and are listed in Table 3-21 of this report. Containers were either glass or plastic and contained acid as a preservative, where applicable.

Holding times for all required analyses are measured from the time of sample collection. The maximum holding times for each analyte are specified in Subsection 2.7.3 of the approved QAPP and are presented in Table 3-21 of this report or in 40 CFR Part 136, No. 209, 26 October 1984.

3.6.4.3 Field and Shipment Chain-of-Custody

A chain-of-custody record was completed for each sample collected to maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory. Prior to shipment of the samples a chain-of-custody record was signed and time-dated by a member of the WESTON field team. This person has verified that those samples indicated on the record are actually contained in the cooler being shipped. Each time samples were transferred the signatures of the persons relinquishing and receiving the samples, as well as the date and time, were documented on the chain-of-custody form. Upon completion of sample packaging for shipment, WESTON/Gulf Coast Laboratories custody seals were placed on the cooler. These seals were used to ensure sample integrity during shipment. The procedures used were consistent with the requirements set forth in Subsections 1.6.1.1 through 1.6.1.3 in the approved QAPP.

Table 3-21

Sample Containers, Sample Volumes, Holding Times, and Preservation, IRP Stage 2, Selfridge ANGB, MI

Aqueous Samples

Analyte	Container	Volume	Preservation	Holding Time[c]
Petroleum hydrocarbons	G, w/teflon-lined silicone rubber septum	2 x 40 mL	Cool, 4°C[a]	14 days
Extractable priority pollutants	G, amber, teflon-lined cap	2 x 1L	Cool, 4°C	7/40[d]
Metals	P, teflon-lined cap	1 L	HNO_3, pH <2, Cool, 4°C[b]	180 days[e]
Common anions (chloride, fluoride, sulfate, phosphate)	P, teflon-lined cap	1 L	None, Cool, 4°C	28 days
Nitrate/nitrite	P, teflon-lined cap	250 mL	H_2SO_4, pH <2, Cool, 4°C	28 days
Alkalinity	P, teflon-lined cap	250 mL	Cool, 4°C	14 days
Nitrogen, ammonia	P, teflon-lined cap	500 mL	H_2SO_4, pH <2, Cool, 4°C	28 days

[a]If samples contain residual chlorine, preserve by adding 0.008 percent sodium thiosulfate solution.
[b]If samples contain residual chlorine, add 0.6 g asorbic acid.
[c]This is the maximum holding time from date of collection.
[d]Extraction within 7 days, analyses within 40 days of extraction.
[e]Mercury holding time is 28 days.
[f]Where possible, soil VOC samples will be collected in brass tubes.
[g]Samples for BNAs, pesticides, herbicides, metals, cyanide, and petroleum hydrocarbons analyses are collected in the same 500-mL jar.

G = Glass
P = Plastic

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Table 3-21
(continued)

Analyte	Container	Volume	Preservation	Holding Time[c]
Aqueous Samples				
TOC	G, amber, teflon-lined cap	125 mL	H_2SO_4, pH <2, Cool, 4°C	28 days
COD	P, teflon-lined cap	250 mL	H_2SO_4, pH <2, Cool, 4°C	28 days
TDS	P, teflon-lined cap	250 mL	Cool, 4°C	7 days
Acidity	P, teflon-lined cap	250 mL	Cool, 4°C	14 days
Soil Samples				
Volatile organic compounds (VOCs) 14 days	G, w/teflon-lined silicone-rubber system[f]	2 x 40 mL		Cool, 4°C
Extractable priority pollutants (BNAs)	G, amber, wide-mouth, teflon-lined cap	500 mL[g]	Cool, 4°C	7/40[d]
Metals	G, amber, wide-mouth, teflon-lined cap	500 mL[g]	Cool, 4°C	180 days[e]
Total petroleum hydrocarbons	G, amber wide-mouth, teflon-lined cap	500 mL[g]	Cool, 4°C	28 days
EP Toxicity Metals	G, amber wide-mouth, teflon-lined cap	500 mL	Cool, 4°C	NA

[a]If samples contain residual chlorine, preserve by adding 0.008 percent sodium thiosulfate solution.
[b]If samples contain residual chlorine, add 0.6 g asorbic acid.
[c]This is the maximum holding time from date of collection.
[d]Extraction within 7 days, analyses within 40 days of extraction.
[e]Mercury holding time is 28 days.
[f]Where possible, soil VOC samples will be collected in brass tubes.
[g]Samples for BNAs, pesticides, herbicides, metals, cyanide, and petroleum hydrocarbons analyses are collected in the same 500-mL jar.

G = Glass
P = Plastic

3.7 ANALYTICAL PROGRAM

3.7.1 Introduction

The sampling program defined under the contract SOW identified sampling points at all eight IRP sites. All soil, groundwater, surface water, and field QA samples were sent to Gulf Coast Laboratories/WESTON Analytics for analysis. The numbers of analyses for each medium and analyte by site are listed in Tables 3-22, 3-23, and 3-24. The exact sampling locations are identified in Figures 3-3 through 3-10 and 3-14 through 3-17.

3.7.2 Laboratory Methods

The laboratory analytical methods used to analyze the soil and water samples are listed in Table 3-25. Table 3-25 also contains for each analytical method a list of parameters determined and the detection limits (see Tables 3-26 through 3-31). The detection limits are based upon instrument detection limits for clean water (with no interference). Instrument detection limits are determined by following the procedures detailed in the WESTON standard Analytical Laboratory Quality Assurance Plan which was included as Appendix A of the approved QAPP. The following are discussions, on selected suites of parameters, of analytical methods and background levels that apply to interpretations of the analytical results.

3.7.2.1 Total Petroleum Hydrocarbons

Petroleum hydrocarbons do not appear naturally in near-surface soils of Michigan, although oil and gas resources have been developed from subsurface deposits associated with the Michigan Basin. Hence, the natural background level for total petroleum hydrocarbons (TPH) in groundwater, surface water, and soils is expected to be zero. Due to analytical interferences, relatively low levels of TPH (up to 10 mg/kg) are frequently reported for uncontaminated natural soils. TPH are usually not detected in uncontaminated water samples. Total petroleum hydrocarbons are analyzed by using a modification of Method 3550, sonication extraction. The method targets petroleum hydrocarbons but is not compound-specific and can sometimes pick up other organics.

3.7.2.2 Volatile Organic Compounds

Volatile organic compounds (VOCs), including purgeable halocarbons and purgeable aromatics, are generally manmade compounds that do not occur naturally in environmental samples. Natural background levels for these compounds are expected to be zero in the samples collected at Selfridge ANGB. As a result of their volatility, VOCs are often difficult to sample, especially when present at low levels. They are easily driven off in

Table 3-22

Summary of Soil Sample Analyses by Site, IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method	SWLF	FTA-2	FTA-1	WRMP	TCLF	NWLF	ERMP	BCSP	Drill Cuttings	Total
Petroleum hydrocarbons	SW3550/E418.1	4	9	9	30	24	2	6	--	--	84
Metals screen (23 metals)	SW3050/SW6010	4	9	9	--	24	2	--	9	--	57
Arsenic	SW3050/SW7060	4	9	9	--	24	2	--	9	--	57
Mercury	SW7471	4	9	9	--	24	2	--	9	--	57
Selenium	SW3050/SW7740	4	9	9	--	24	2	--	9	--	57
Volatile organic compounds	SW5030/SW8240	4	9	9	30	24	2	6	--	--	84
Extractable priority pollutants	SW3550/SW82790	4	--	9	--	24	2	--	9	--	48
EP toxicity	40 CFR 261.24	--	--	--	1	--	--	1	--	--	2
Soil moisture	ASTM D2216	4	9	9	30	24	2	6	--	--	84

-- Analyses not required by Work Plan.

Table 3-23

Summary of Groundwater Sample Analyses by Site, IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method	SWLF*	FTA-2	FTA-1	WRMP	TCLF	NWLF	ERMP	BCSP	Total
Alkalinity (carbonate, bicarbonate, and hydroxide (in situ))	A403	12	3	3	12	9	7	11	4	61
Nitrogen, ammonia	E530.3	12	--	--	--	9	7	--	--	28
Common anions (chloride, sulfate, orthophosphate)	A429	12	3	3	12	9	7	11	4	61
Nitrate/nitrite	E353.1	12	3	3	3	9	7	11	4	61
Fluoride	E340.2	12	3	3	12	9	7	11	4	61
Total organic carbon (TOC)	E415.1	12	--	--	--	9	7	--	--	28
Chemical oxygen demand (COD)	A508A	12	--	--	--	9	7	--	--	28
Total dissolved solids (TDS)	E160.1	12	3	3	12	9	7	11	4	61
Specific conductance (field test)	E120.1	12	3	3	12	9	7	11	4	61
pH (field test)	E150.1	12	3	3	12	9	7	11	4	61
Temperature (field test)	E170.1	12	3	3	12	9	7	11	4	61

* Numbers below each site represent the total number of groundwater samples collected.
— Analyses not required by Work Plan.

Table 3-23
(continued)

Parameter	Analytical Method	SWLF*	FTA-2	FTA-1	WRMP	TCLF	NWLF	ERMP	BCSP	Total
ICP metals screen (23 metals)	E200.7	12	3	3	--	9	7	--	4	38
Arsenic	E206.2	12	3	3	--	9	7	--	4	38
Lead	E239.2	12	3	3	--	9	7	-	4	38
Mercury	E245.1	12	3	3	--	9	7	--	4	38
Selenium	E270.2	12	3	3	--	9	7	--	4	38
Petroleum hydrocarbons	E418.1	12	3	3	12	9	7	11	--	57
Purgeable halocarbons	E601	12	3	3	3	9	7	---	--	37
Acidity	E305.1	--	--	--	--	--	--	--	4	4
Extractable priority pollutants	E625	12	--	--	--	9	7	--	4	32
Purgeable aromatics	SW5030/ SW8020	12	3	3	12	9	7	11	--	57

* Numbers below each site represent the total number of groundwater samples collected.
— Analyses not required by Work Plan.

Table 3-24

Summary of Surface Water Sample Analyses by Site, IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method	SWLF*	FTA-2	FTA-1	WRMP	TCLF	NWLF	ERMP	BCSP	Total
Alkalinity (carbonate, bicarbonate,and hydroxide (in situ))	A403	10	7	--	8	10	4	8	--	47
Nitrogen, ammonia	E530.3	10	--	--	--	10	4	--	--	24
Common anions (chloride, sulfate, orthophosphate)	A429	10	7	--	8	10	4	8	--	47
Nitrate/nitrite	E353.1	10	6	--	8	10	4	8	--	46
Fluoride	E340.2	10	7	--	8	10	4	8	--	47
Total organic carbon (TOC)	E415.1	10	--	--	--	10	4	--	--	24
Chemical oxygen demand (COD)	A508A	8	--	--	--	9	4	--	--	21
Total dissolved solids (TDS)	E160.1	8	6	--	8	9	4	8	--	43
Specific conductance (field test)	E120.1	10	7	--	8	10	4	8	--	47
pH (field test)	E150.1	10	7	--	8	10	4	8	--	47
Temperature (field test)	E170.1	10	7	--	8	10	4	8	--	47

* Numbers below each site represent the total number of surface water samples taken during two rounds of sample collection.
-- Analyses not required by Work Plan.

Table 3-24
(continued)

Parameter	Analytical Method	SWLF*	FTA-2	FTA-1	WRMP	TCLF	NWLF	ERMP	BCSP	Total
ICP metals screen (23 metals)	E200.7	10	7	—	—	10	4	—	—	31
Arsenic	E206.2	10	7	—	—	10	4	—	—	31
Lead	E239.2	10	7	—	—	10	4	—	—	31
Mercury	E245.1	10	7	—	—	10	4	—	—	31
Selenium	E270.2	10	7	—	—	10	4	—	—	31
Petroleum hydrocarbons	E418.1	10	7	—	8	9	4	8	—	46
Purgeable halocarbons	E601	10	7	—	—	10	4	—	—	31
Acidity	E305.1	—	—	—	—	—	—	—	—	0
Extractable priority pollutants	E625	10	—	—	—	10	4	—	—	24
Purgeable aromatics	SW5030/ SW8020	10	7	—	8	10	4	8	—	47

* Numbers below each site represent the total number of surface water samples taken during two rounds of sample collection.
— Analyses not required by Work Plan.

Table 3-25

Analytical Methods and Detection Limits, IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method	Detection Limit	Reporting Units
Water samples			
Alkalinity (carbonate, bicarbonate)	A403	10	mg/L
Nitrogen, ammonia	E350.3	0.01	mg/L
Common anions (chloride, sulfate, phosphate)	A429	2.5	mg/L
Fluoride	E340.2	0.1	mg/L
Nitrate/nitrite	E353.1	0.1	mg/L
Total organic carbon (TOC)	E415.1	1	mg/L
Chemical oxygen demand (COD)	A508A	5	mg/L
Acidity	E305.1	10	mg/L
Petroleum hydrocarbons	E418.1	1	mg/L
Total dissolved solids (TDS)	E160.1	10	mg/L
pH (field test)	E150.1	--	pH units
Specific conductance (field test)	E120.1	--	umho/cm*

*Micro-mho/centimeter

Table 3-25
(continued)

Parameter	Analytical Method	Detection Limit	Reporting Units
Water samples			
Temperature (field test)	E170.1	--	deg. C
Arsenic	E206.2	0.005	mg/L
Lead	E239.2	0.005	mg/L
Mercury	E245.1	0.001	mg/L
Selenium	E270.2	0.005	mg/L
Metals screen	E200.7	(see Table 3-26)	mg/L
Purgeable halo-carbons	E601	(see Table 3-27)	ug/L
Purgeable aromatics	SW5030/ SW8020	(see Table 3-28)	ug/L
Extractable priority pollu-tants	E625	(see Table 3-29)	ug/L

Table 3-25
(continued)

Parameter	Analytical Method	Detection Limit	Reporting Units
Soil samples			
Petroleum hydrocarbons	SW3550/ E418.1	50	mg/kg
Arsenic	SW3050/ SW7060	0.5	mg/kg
Mercury	SW7471	0.5	mg/kg
Selenium	SW3050/ SW7740	1	mg/kg
Soil moisture	ASTM D2216	--	percent
Metals screen	SW3050/ SW6010	(see Table 3-26)	mg/kg
Volatile organic compounds	SW5030/ SW8240	(see Table 3-30)	mg/kg
Extractable priority pollutants	SW3550/ SW8270	(see Table 3-29)	mg/kg
EP toxicity	40 CFR 261.24	(see Table 3-31)	mg/kg

Table 3-26

Metal Detection Limits, IRP Stage 2, Selfridge ANGB, MI

Analyte	Detection Limit Water (mg/L)	Detection Limit Soil/Sediment (mg/kg)
Silver	0.03	4
Aluminum	0.2	20
Arsenic	0.005	0.5
Boron	0.1	20
Barium	0.05	2.5
Beryllium	0.002	0.2
Calcium	0.2	10
Cadmium	0.005	2
Cobalt	0.04	4
Chromium	0.03	4
Copper	0.03	3
Iron	0.04	4
Mercury	0.005	0.5
Potassium	(determined at time of analyses)	
Magnesium	0.2	20
Manganese	0.01	1
Molybdenum	0.1	20
Sodium	0.9	90
Nickel	0.015	5
Lead	0.005	20
Antimony	0.2	20
Selenium	0.005	1
Silicon	0.3	30
Thallium	0.2	20
Vanadium	0.04	4
Zinc	0.01	1

Table 3-27

Purgeable Halocarbon Compound Detection Limits,
IRP Stage 2, Selfridge ANGB, MI

Analyte	Detection Limit in Water (ug/L)
Chloromethane	0.70
Bromomethane	6.0
Dichlorodifluoromethane	9.0
Vinyl chloride	0.30
Chloroethane	3.0
Methylene chloride	2.0
Trichlorofluoromethane	5.0
1,1-Dichloroethene	0.70
1,1-Dichloroethane	0.40
trans-1,2-Dichloroethene	0.50
Chloroform	0.20
1,2-Dichloroethane	0.20
1,1,1-Trichloroethane	0.20
Carbon tetrachloride	0.60
Bromodichloromethane	0.50
1,2-Dichloropropane	0.20
trans-1,3-Dichloropropene	2.0
Trichloroethene	0.60
Dibromochloromethane	0.50
1,1,2-Trichloroethane	0.20
cis-1,3-Dichloropropene	1.0
2-Chloroethyl vinyl ether	0.80
Bromoform	1.0
Tetrachloroethene	0.20
1,1,2,2-Tetrachloroethane	0.30
Chlorobenzene	1.2
1,2-Dichlorobenzene	0.50
1,3-Dichlorobenzene	1.0
1,4-Dichlorobenzene	1.0

Table 3-28

Purgeable Aromatic Compound Detection Limits,
IRP Stage 2, Selfridge ANGB, MI

Analyte	Detection Limit in Water (ug/L)
Benzene	2.0
Toluene	2.0
Chlorobenzene	5.0
Ethylbenzene	2.0
1,2-Dichlorobenzene	5.0
1,3-Dichlorobenzene	5.0
1,4-Dichlorobenzene	5.0
Xylenes	5.0

Table 3-29

Extractable Priority Pollutant Compound Detection Limits, IRP Stage 2, Selfridge ANGB, MI

Analyte	Detection Limit	
	Water (ug/L)	Soil/Sediment (mg/kg)
Phenol	10	0.5
Bis(2-chloroethyl) ether	10	0.5
2-Chlorophenol	10	0.5
1,3-Dichlorobenzene	10	0.5
1,4-Dichlorobenzene	10	0.5
1,2-Dichlorobenzene	10	0.5
Bis(2-chloroisopropyl) ether	10	0.5
N-nitroso-di-n-propylamine	10	0.5
Hexachloroethane	10	0.5
Nitrobenzene	10	0.5
Isophorone	10	0.5
2-Nitrophenol	50	0.5
2,4-Dimethylphenol	10	0.5
Bis(2-chloroethoxy) methane	10	0.5
2,4-Dichlorophenol	10	0.5
1,2,4-Trichlorobenzene	10	0.5
Naphthalene	10	0.5
Hexachlorobutadiene	10	0.5
4-Chloro-3-methylphenol	10	0.5
2,4,6-Trichlorophenol	10	0.5
2,4,5-Trichlorophenol	50	1.5
2-Chloronaphthalene	10	0.5
Dimethyl phthalate	10	0.5
Acenaphthylene	10	0.5
2,6-Dinitrotoluene	10	0.5
Acenaphthene	10	0.5
2,4-Dinitrophenol	50	1.5
4-Nitrophenol	50	0.5
2,4-Dinitrotoluene	10	0.5
Diethyl phthalate	10	0.5
4-Chlorophenyl phenyl ether	10	0.5
Fluorene	10	0.5
4,6-Dinitro-2-methylphenol	50	1.5
4-Bromophenyl phenyl ether	10	0.5
Hexachlorobenzene	10	0.5
Pentachlorophenol	50	0.5

Table 3-29
(continued)

Analyte	Detection Limit Water (ug/L)	Detection Limit Soil/Sediment (mg/kg)
Phenanthrene	10	0.5
Anthracene	10	0.5
Di-n-butyl phthalate	10	0.5
Fluoranthene	10	0.5
Pyrene	10	0.5
Butyl benzyl phthalate	10	0.5
3,3'-Dichlorobenzidine	20	0.5
Benzo(a)anthracene	10	0.5
Chrysene	10	0.5
Bis(2-ethylhexyl) phthalate	10	0.5
Di-n-octyl phthalate	10	0.5
Benzo(b)fluoranthene	10	0.5
Benzo(k)fluoranthene	10	0.5
Benzo(a)pyrene	10	0.5
Indeno(1,2,3-c,d)pyrene	10	0.5
Dibenzo(a,h)anthracene	10	0.5
Benzo(g,h,i)perylene	10	0.5

Table 3-30

Volatile Organic Compound Detection Limits, IRP Stage 2, Selfridge ANGB, MI

Analyte	Detection Limit Soil/Sediment (mg/kg)
Chloromethane	0.01
Bromomethane	0.01
Vinyl chloride	0.01
Chloroethane	0.01
Methylene chloride	0.005
Acetone	0.01
Carbon disulfide	0.005
1,1-Dichloroethene	0.005
1,1-Dichloroethane	0.005
1,2-Dichloroethene (total)	0.005
Chloroform	0.005
1,2-Dichloroethane	0.005
2-Butanone	0.01
1,1,1-Trichloroethane	0.005
Carbon tetrachloride	0.005
Bromodichloromethane	0.005
1,2-Dichloropropane	0.005
cis-1,3-Dichloropropene	0.005
Trichloroethene	0.005
Dibromochloromethane	0.005
1,1,2-Trichloroethane	0.005
Benzene	0.005
trans-1,3-Dichloropropene	0.005
Bromoform	0.005
4-Methyl-2-pentanone	0.01
Tetrachloroethene	0.005
1,1,2,2-Tetrachloroethane	0.005
Toluene	0.005
Chlorobenzene	0.005
Ethylbenzene	0.005
Xylenes (Total)	0.005
Diethyl ether	0.1
Trichlorofluoromethane	0.01
2-Chloroethyl vinyl ether	0.01
1,3-Dichlorobenzene	0.01
1,4-Dichlorobenzene	0.01
1,2-Dichlorobenzene	0.01

Table 3-31

Metal EP Toxicity Detection Limits,
IRP Stage 2, Selfridge ANGB, MI

Analyte	Analytical Method	Detection Limit	Reporting Units
Silver	SW1310/SW7760	0.5	mg/L
Arsenic	SW1310/SW7061	0.54	mg/L
Barium	SW1310/SW7080	0.05	mg/L
Cadmium	SW1310/SW7130	0.1	mg/L
Chromium	SW1310/SW7190	0.5	mg/L
Mercury	SW1310/SW7470	0.5	mg/L
Lead	SW1310/SW7420	0.5	mg/L
Selenium	SW1310/SW7741	0.1	mg/L

the sampling process or may be introduced as cross-contamination in sampling, storage, transport, and analysis.

VOC analyses were performed using gas chromatograph/mass spectrometer (GC/MS) methods for soil and water media. The GC/MS method is very compound-specific, although quantification is generally not good below 5 to 10 micrograms per kilogram (ug/kg) in soil, or 5 to 10 ug/L in water. In some cases where a sample contains high levels of organics (either naturally or through contamination), the sample is diluted, and detection levels may be raised by one or more orders of magnitude.

3.7.2.3 Extractable Priority Pollutants

Extractable priority pollutants -- also known as base-neutral and acid-extractables (BNAs) or semivolatile organic compounds -- are heavier, generally less mobile environmental compounds than VOCs. Although some BNAs are naturally occurring, their background concentrations are generally assumed to be zero.

Analyses for these compounds were performed using GC/MS methods for soil and water media. For BNA analyses, GC/MS provides quantification down to concentrations of 10 to 1,000 ug/kg in soils and 10 to 1,000 ug/L in water, depending on the dilution factor for the sample quantified. Tentatively identified compounds (TICs) are compounds for which the analytical method is not calibrated. These compounds are not discussed in this report since they are only identified tentatively. TICs for the IRP Stage 2 studies at Selfridge ANGB were reported in the Informal Technical Information Report (WESTON, October 1988).

3.7.2.4 Metals

The metals analyzed for the IRP Stage 2 studies were silver, aluminum, arsenic, boron, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, mercury, potassium, magnesium, manganese, molybdenum, sodium, nickel, lead, antimony, selenium, silicon, thallium, vanadium, and zinc. The samples were analyzed by atomic absorption spectrophotometry, except for mercury, which was analyzed using a cold vapor mercury analyzer.

Atomic absorption spectrophotometry is a very accurate, quantitative analytical method, with quantification to 5 to 10 ug/kg in soil and 5 to 10 ug/L in water for many metals. Occasional matrix (sample medium) interferences can reduce the level of quantification. All metals analyzed are naturally present in soils at levels characteristic of a given region and its geology. No site-specific data for the Selfridge ANGB area were available in the literature.

3.7.3 Laboratory Custody Procedures

Sample chain-of-custody procedures were implemented upon sample receipt, storage, preparation, and analyses. Security measures were also undertaken to ensure sample integrity. Upon receipt, the sample custodian signs the chain-of-custody record, thus assuming custody of the samples. Samples are then compared to the information recorded on the chain-of-custody record and for sample integrity. Any problems are noted on the chain-of-custody record.

Once initial sample inspection has been completed, the samples are transferred to a locked storage refrigerator maintained at 4°C ± 2°C. Samples removed for analyses are signed out on the chain-of-custody form by both the analyst and sample custodian. Sample tracking forms are also used to document sample extraction prior to actual analyses. These procedures were implemented as specified in Subsection 1.6.1.4 of the approved QAPP.

3.8 QUALITY ASSURANCE AND QUALITY CONTROL

Consistent with WESTON's corporate policies and practices and with requirements of the SOW, quality assurance and quality control (QA/QC) measures were incorporated in the performance of the field program and the reduction and evaluation of the data. These measures included the specification of procedures to be used, the implementation of those procedures in a controlled and monitored program, and the collection and analysis of QA/QC samples to serve as the basis for validating the chemical analytical data from the laboratory.

3.8.1 Specification of Procedures

Prior to initiating work on IRP Stage 2, a Work Plan and a Quality Assurance Project Plan (QAPP) were prepared. The Work Plan described the background, environmental setting, and basis for the overall approach to the IRP Stage 2 program. This information provides a framework for understanding the objectives of the IRP, the features of a site that could be significant to environmental studies, and the main aspects of a phased remedial investigation and feasibility study consistent with CERCLA and SARA. This framework ensures the focus of the specific activities undertaken during Stage 2 studies on the key data needed to characterize the environmental hazards posed by the sites, if any, and to identify and select appropriate remedial measures. The Work Plan also describes the general requirements for field work, data management, data evaluation (including the scope of the qualitative risk assessment and preliminary feasibility study), and reporting.

The QAPP (see Appendix F) describes in detail the objectives and procedures for QA/QC of sampling and analysis activities and the procedures to be used in performing other field activities. The QAPP includes discussions of QA/QC responsibilities; chain-of-custody; documentation of activities in field notebooks and with photographs; sample packaging and shipment; calibration of field and laboratory instruments; analytical procedures for field and laboratory testing, data reduction, validation, and assessment procedures; internal QC checks and audits; and corrective action and reporting. Field procedures for test boring and drilling; monitor well installation; water level measurement; sampling of soil, surface water, and groundwater; decontamination; sample preservation and handling; and site management are also discussed in the QAPP. This plan was used both in the field and in the laboratory to provide on-the-scene guidance and direction during performance of IRP Stage 2 activities.

The Work Plan and QAPP were reviewed and approved by USAFOEHL/TS. In addition to these plans, WESTON's operating divisions and departments have written Quality Assurance Plans. These plans specify QA/QC measures to be used in routine performance of data reduction, data evaluation, and report preparation. These measures included standardized project file organization, verification (checking) of electronic data key-entry, checking of calculations, peer review of technical method selection and implementation, review by senior staff within technical disciplines, and review by project and program management. The performance of these measures are documented in single-page forms, allowing the entire history of QA/QC reviews for a specific analysis, table, figure, or report section to be fully traced.

3.8.2 Implementation of Procedures

The QA/QC procedures identified during planning for Stage 2 activities were implemented in a controlled and monitored program. Implementation control was achieved through daily briefings of field crews by the Field Team Leader, with on-the-scene references to the QAPP and Health and Safety Plan. Field notes were reviewed and consolidated regularly, with completed data forms being removed from field binders and placed in field office files. Sample tracking data were entered into the field portable computer following each sample shipment. Office control was maintained through weekly progress and planning meetings, from which specific assignments were made for activities, direction provided, and appropriate technical approaches identified for data reduction and evaluation, and level of effort budgets and schedules were set.

Monitoring of activities was accomplished through field audits and QA/QC documentation from tracking. Two field audits were performed to verify use of correct field procedures. Specific activities observed during these audits included monitor well

construction and development, decontamination, equipment calibration, documentation, groundwater sampling, water level data collection, and health and safety. These audits identified some minor discrepancies between the QAPP and actual procedures and recommended actions to alleviate these discrepancies. These corrective actions were incorporated in subsequent field operations. All originals of QA/QC documentation forms were submitted to the Task Manager on a weekly basis. From these forms and those generated by his own QA/QC activities, the Task Manager maintained an up-to-date picture of the status and general quality of the several activities occurring in parallel at any given time.

3.8.3 QA/QC Samples

3.8.3.1 Field QA/QC Samples

Field QA/QC samples, including trip blanks, ambient condition blanks, equipment blanks, field duplicates, and field replicates, were collected for analyses as part of all soil, groundwater, and surface water sampling. These samples were collected and handled in the same manner as the investigative samples in accordance with the protocols specified in Subsection 2.8 of the approved QAPP.

- Trip blanks were prepared in the laboratory and were shipped to the site with the sample bottles. Each was handled like an investigative sample. One trip blank being shipped back to the laboratory with every 10 VOC samples (both soil and water) collected or for every shipment of VOC samples.

- Ambient conditions blanks were collected for every 10 water samples collected for VOC analyses. These samples were collected by pouring ASTM Type II Reagent water into a sample bottle at designated field sampling locations. The blanks were handled as samples and were shipped back to the laboratory with the other VOC samples from that site or zone

- Equipment blanks were collected for every 10 groundwater and surface water samples collected. These blanks were analyzed for the same parameters as the groundwater. These samples were collected by pouring ASTM Type II Reagent water through the sampling device (e.g., teflon bailer) and into the appropriate sampling container. Equipment blanks for soluble metals were passed through the filtering apparatus in the same manner as the groundwater samples.

- Field duplicates of groundwater and surface water samples were collected at a rate of 10 percent of the total number of samples collected. The sampling protocol

of the field duplicates was identical to the original investigative samples, as they were collected immediately afterwards using the same sampling equipment and procedures.

- Field replicates were also collected for soil samples. The number of replicates was equal to 10 percent of the total number of samples. Replicate soil samples were collected by dividing the soil into two equal parts and placing one-half of the soil into the investigative sample jar and one-half of the soil into the replicate sample jar.

The numbers of field QA/QC samples for soil and water are listed in Tables 3-32 and 3-33, respectively.

3.8.3.2 Laboratory QA/QC Samples

The daily quality of analytical data generated in the WESTON laboratories is controlled by the implementation of WESTON's standard Analytical Laboratory Quality Assurance Plan (see Appendix A in the approved QAPP). As specified in the plan under "Method Performance" and further described in Subsection 1.10.2 of the approved QAPP, the types and frequencies of internal quality control checks have been defined for each analysis type. In general, internal laboratory QC checks consist of the following:

- Method Blank. A method blank consists of laboratory reagent-grade water treated in the same manner as the investigative samples (i.e., digested, extracted, distilled, etc.).

- Method Blank Spike. A method blank spike is a sample of laboratory reagent-grade water fortified (spiked) with the analytes of interest which is prepared and analyzed with the associated sample batch. Method blank spikes were not included with VOC analyses since the same function is served by the calibration standard analysis.

- Matrix Spike and Matrix Spike Duplicate. A matrix spike is an aliquot of a field sample which is fortified (spiked) with the analytes of interest and analyzed with an associated sample batch. A matrix spike duplicate is a duplicate analysis of a sample that will be fortified or spiked. Matrix spikes and matrix spike duplicates are performed only in association with selected protocols, as specified in the Analytical Laboratory Quality Assurance Plan. For each sample round, matrix spikes and matrix spike duplicate were prepared once every 20 samples per matrix.

Table 3-32

Number of Quality Control Soil Sample Analyses, IRP Stage 2, Selfridge ANGB, MI

Parameter	Analytical Method	Dup/Rep	Trip Blanks
Petroleum hydrocarbons	SW3550/E418.1	9	--
Metals screen (23 metals)	SW3050/SW6010	5	--
Arsenic	SW3050/SW7060	5	--
Mercury	SW7471	5	--
Selenium	SW3050/SW7740	5	--
Volatile organic compounds	SW5030/SW8240	9	11
Extractable priority pollutants	SW3550/SW82790	4	--
EP toxicity	40 CFR 261.24	2	--
Soil moisture	ASTM D2216	9	--

Table 3-33

Number of Quality Control Water Sample Analyses, IRP Stage 2, Selfridge ANGB, MI

Parameter	Groundwater					Surface Water				
	Dup/Rep	Amb Cond. Blanks	Trip Blanks	Equip. Blanks	Second Column	Dup/Rep	Amb Cond. Blanks	Trip Blanks	Equip. Blanks	Second Column
Alkalinity (carbonate, bicarbonate, and hydroxide (in situ))	7	--	--	7	--	4	--	--	4	--
Nitrogen, ammonia	3	--	--	3	--	2	--	--	2	--
Common anions (chloride, sulfate, orthophosphate)	7	--	--	7	--	4	--	--	4	--
Nitrate/nitrite	3	--	--	3	--	2	--	--	2	--
Fluoride	7	--	--	7	--	4	--	--	4	--
Total organic carbon (TOC)	3	--	--	3	--	2	--	--	2	--
Chemical oxygen demand (COD)	3	--	--	3	--	2	--	--	2	--
Total dissolved solids (TDS)	7	--	--	7	--	4	--	--	4	--
ICP metals screen (23 metals)	5	--	--	5	--	2	--	--	4	--
Arsenic	5	--	--	5	--	2	--	--	2	--

Table 3-33
(continued)

Parameter	Groundwater Dup/Rep	Groundwater Amb Cond. Blanks	Groundwater Trip Blanks	Groundwater Equip. Blanks	Groundwater Second Column	Surface Water Dup/Rep	Surface Water Amb Cond. Blanks	Surface Water Trip Blanks	Surface Water Equip. Blanks	Surface Water Second Column
Lead	5	--	--	5	--	2	--	--	2	--
Mercury	5	--	--	5	--	2	--	--	2	--
Selenium	5	--	--	5	--	2	--	--	2	--
Petroleum hydrocarbons	6	--	--	6	--	4	--	--	4	--
Purgeable halocarbons	4	4	8	4	24	2	1	2	2	17
Acidity	1	--	--	1	--	--	--	--	--	--
Extractable priority pollutants	4	--	--	4	--	2	--	--	2	--
Purgeable aromatics	6	6	10	6	7	4	2	2	4	6

- Laboratory Duplicate Sample. A duplicate sample is obtained by splitting a field sample into two separate aliquots and performing two separate analyses on the aliquots. Laboratory duplicates were run and reported for specific analyses only, as specified in the Analytical Laboratory Quality Assurance Plan. For each sample round, a laboratory duplicate will be run with every 20 field samples.

In addition to the quality control samples described above, three additional types of independent quality control checks (not associated with field sample batches) were routinely analyzed in the laboratory. These are the following:

- Laboratory Control Standard for Inorganics. This is a standard solution with a certified concentration analyzed as a sample and used to monitor analytical accuracy.

- Blind Performance Sample. This is a QC sample of known concentration obtained from the U.S. EPA, the National Bureau of Standards (NBS), or a commercial source. The blind performance sample is not recognizable to the analyst as a performance sample and is used to monitor analytical accuracy.

- Known Performance Sample. A known performance sample is the same as a blind performance sample, but is identified to the analyst so that he/she may use it to check the accuracy of an analytical procedure. It is particularly applicable when a minor revision or adjustment has been made to an analytical procedure or instrument.

3.8.3.3 Use and Interpretation of QA/QC Sample Data

The field and laboratory QA/QC samples provide assurance of the veracity of the sampling and analysis procedures. The specific quality assurance purpose of each QA/QC samples is detailed in the following paragraphs.

Field QA/QC Samples:

- Trip Blank. A trip blank monitors the investigative samples for possible contamination during transportation to and from the laboratory. Any contamination of the investigative samples which occurred by handling and storage should also be found in the trip blank. If an analyte does occur in the trip blank, it must have occurred in at least five times that concentration in the investigative sample before it was considered an analyte detected in the environment.

- Field Duplicate/Field Replicate. These samples are utilized to monitor variability in sampling techniques and/or degree of heterogeneity in a particular sample. If the field duplicates or field replicates results show significant disparity, then the sampling procedures for that group of samples must be questioned. However, in the case of soil samples, any disparity most likely indicates the heterogeneity of the soil.

- Equipment Blank. An equipment blank monitors the effectiveness of the decontamination procedure for the sampling equipment. In addition, it monitors the potential for cross-contamination. If the solvents used for decontamination occur consistently in the equipment blanks, then the decontamination procedures must be questioned. If any analyte does occur in the equipment blank, it must have occurred in at least five times that concentration in the investigative sample before it was considered an analyte detected in the environment.

- Ambient Condition Blank. This blank is used to monitor possible contamination due to sampling procedures and field conditions. Because these blanks are prepared at the sampling location, any conditions that result in contamination of the investigative samples will also contaminate the ambient condition blanks. If any analyte does occur in the ambient condition blank, it must have occurred in at least five times that concentration in the investigative sample before it was considered an analyte detected in the environment.

Laboratory QA/QC Samples:

- Method Blank. A method blank monitors the analytical procedures and the existence and magnitude of contamination introduced via the analytical scheme. It provides a baseline of detection limits for the investigative samples. If any analyte does occur in the method blank, it must have occurred in at least five times that concentration in the investigative sample before it was considered an analyte detected in the environment.

- Method Blank Spike. A method blank spike provides a baseline of detection for later comparison with matrix spikes. By fortifying laboratory reagent-grade water, it was possible to check the response of the instruments to known quantities of analytes.

- Laboratory Duplicate. This sample monitors the variability in laboratory techniques and analytical methods. Laboratory duplicate results may be disparate, to a certain degree, due to sample inhomogeneity, especially soil samples. Major disparities indicate analytical problems, if they occur.

- Matrix Spike and Matrix Spike Duplicate. These samples are used to check the efficiency of the analytical instrumentation in detecting a known quantity of a compound. The spikes also monitor possible interferences in the field samples. These interferences were caused, if present, by the matrix of the sample and the presence of compounds that masked the detection of the desired analytes.

- Surrogate Spike and Laboratory Control Spike. A surrogate spike was added to every investigative and quality control sample at analysis. These were used to monitor instrument and analytical precision and the response of the instrument at the time of analysis. Laboratory control spikes were used to monitor analytical accuracy.

3.8.3.4 Validation of Analytical Data

Analytical data from environmental investigative samples were considered valid only if a number of strict quality control/quality assurance criteria were met satisfactorily. These criteria are as follows:

(1) Valid field sampling methods were used.

(2) Acceptable sample handling, preservation, and packaging methods were used.

(3) Samples were tracked by chain-of-custody documentation.

(4) Samples were analyzed within acceptable holding times and acceptable detection limits as set by EPA methods of analysis.

(5) Analytical methods were checked by laboratory quality control samples and procedures.

(6) Sample quality was checked by associated field quality control samples.

The field sampling methods (criterion 1) are documented in Subsections 3.4 and 3.6. The sample handling, preservation, and packaging methods (criterion 2) are documented in Subsection 3.6.4. The chain-of-custody documentation (criterion 3) is

included in Appendix K and is described in Subsection 3.6.4.3. Holding times and method quantitation limits (criterion 4) are documented in the October 1988 Interim Technical Information Report (ITIR). Descriptions of holding times exceeded and the analytes resampled are included in the contamination profiles of each site, which are presented in Subsections 4.4 through 4.11. Methods used for checking the analytical procedures (criterion 5) are documented in Subsection 3.7. The results of these methods are itemized in the case narratives that were included with the laboratory analytical data in the ITIR. Summaries of the laboratory quality control methods are included in the contamination profiles of each site, which are presented in Subsections 4.4 through 4.11. The contaminants found in the field quality control samples (criterion 6) are also presented in these subsections.

The investigative and field quality control samples were assigned specific batch numbers when they were received by the laboratory. The samples within a batch were extracted (if necessary) and analyzed as distinct groups. Each batch, therefore, had its own unique quality control samples. Validation of the analytical data was done by laboratory batch.

A number of analytes were detected in the method blanks and the field quality control blanks. These analytes are listed in Table 3-34 (soil samples) and Table 3-35 (groundwater and surface water samples). The investigative samples were then screened by batch for analytes detected in corresponding method and field quality control blanks. If an analyte detected in a quality control blank was detected in an investigative sample of the same batch, the analyte must have occurred at 5 times the concentration in the quality control blank to be valid in the investigative sample. Tables listing by sample the analytes detected in field quality control blanks and method blanks and the investigative analytes that were invalidated are included in Appendix L.

Table 3-34

Analytes Detected in Quality Control Blanks for Soil Samples -- Spring 1988, IRP Stage 2, Selfridge ANGB, MI

Analyte	Method	No. Detects in Method Blanks	Concentration Range	No. Detects in Trip Blanks	Concentration Range
Methylene chloride	SW5030/SW8240	12	<0.001 - 0.005	11	<0.005 - 0.015
Acetone	SW5030/SW8240	19	<0.002 - 0.012	9	<0.004 - 0.032
Chloroform	SW5030/SW8240	0	ND	2	<0.001 - <0.003
2-Butanone	SW5030/SW8240	4	<0.004 - 0.006	1	0.015
1,1,1-Trichloroethane	SW5030/SW8240	2	0.005	1	0.010
4-Methyl-2-pentanone	SW5030/SW8240	2	<0.002	0	ND
Toluene	SW5030/SW8240	2	<0.004	4	<0.002 - 0.015
Bis(2-ethylhexyl) phthalate	SW3550/SW8270	3	0.030 - 0.080	NA	NA
Copper	SW3050/SW6010	4	4.2	NA	NA
Iron	SW3050/SW6010	4	4.5 - 5.8	NA	NA
Calcium	SW3050/SW6010	1	11.1	NA	NA
Silicon	SW3050/SW6010	1	22.9	NA	NA
Cobalt	SW3050/SW6010	1	12.9	NA	NA
Zinc	SW3050/SW6010	2	1 - 1.6	NA	NA

All concentrations are in mg/kg.
ND - Not detected.
NA - Not applicable.

Table 3-35

Analytes Detected in Quality Control Blanks for Water Samples -- Spring 1988, IRP Stage 2, Selfridge ANGB, MI

Analyte	Method	Units	Method Blanks Detects	Method Blanks Conc.	Trip Blanks Detects	Trip Blanks Conc.	Ambient Blanks Detects	Ambient Blanks Conc.	Equipment Blanks Detects	Equipment Blanks Conc.
Methylene chloride	E601	ug/L	7	2 - 4	2	4 - 22	1	4	2	2 - 5
Chloroform	E601	ug/L	0	ND	1	0.4	6	2.5 - 8.1	6	2.8 - 9.2
Bromodichloromethane	E601	ug/L	0	ND	0	ND	1	0.7 - 1.2	1	0.5 - 1.3
Toluene	SW5030/SW8020	ug/L	0	ND	1	3 - 10	0	ND	0	ND
Diethyl phthalate	E625	ug/L	1	<2	NA	NS	NA	NS	1	<2
Di-n-butyl phthalate	E625	ug/L	3	<1	NA	NS	NA	NS	1	<2
Bis(2-ethylhexyl) phthalate	E625	ug/L	4	<1 - 25	NA	NS	NA	NS	6	<2 - 48
Calcium	E200.7	mg/L	0	ND	NA	NS	NA	NS	5	0.319 - 0.464
Copper	E200.7	mg/L	0	ND	NA	NS	NA	NS	1	0.026
Iron	E200.7	mg/L	0	ND	NA	NS	NA	NS	4	0.043 - 0.089
Silicon	E200.7	mg/L	0	ND	NA	NS	NA	NS	4	0.346 - 1.16
Zinc	E200.7	mg/L	0	ND	NA	NS	NA	NS	5	0.011 - 0.099
Sulfate	A429	mg/L	0	ND	NA	NS	NA	NS	1	22.9
Alkalinity	A403	mg/L	0	ND	NA	NS	NA	NS	1	300
Fluoride	E340.2	mg/L	0	ND	NA	NS	NA	NS	11	0.1 - 0.7
Ammonia	E350.3	mg/L	0	ND	NA	NS	NA	NS	4	0.1 - 0.7
TOC	E415.1	mg/L	0	ND	NA	NS	NA	NS	2	1.2 - 1.6
Total dissolved solids	E160.1	mg/L	0	ND	NA	NS	NA	NS	4	10.26
Petroleum hydrocarbons	E418.1	mg/L	0	ND	NA	NS	NA	NS	8	1.1 - 2.2

NA - Not applicable.
NS - Not sampled.
ND - Not detected.
Conc. - Concentration detected.

SECTION 4

RESULTS AND SIGNIFICANCE OF FINDINGS

4.1 CHARACTERIZATION OF BASEWIDE PHYSICAL SETTING, MIGRATION PATHWAYS, AND RECEPTORS

The IRP Stage 2 study at Selfridge ANGB examined surficial and subsurface conditions at each of the eight sites investigated. This subsection presents a summary of the physical setting, migration pathways, and receptors common to all eight sites as determined from the observations and data collected during this as well as previous IRP studies. A basewide assessment of these conditions allows some additional insights beyond those resulting from the evaluation of site-by-site conditions presented later in Section 4.

The physical setting is characterized as a function of soil and subsurface geology, groundwater, and surface drainage conditions. Characterization of the physical setting indicates that groundwater and surface water movement are the primary potential pathways for contaminant migration at Selfridge ANGB. In addition to general populations at the base who may be exposed to contaminants from the IRP sites, each of these pathways has distinct groups of potential receptors.

4.1.1 Soil and Subsurface Geology Conditions

The surficial soils and subsurface geology at Selfridge ANGB have been characterized primarily on the basis of the data collected from soil and monitor well borings installed during the IRP Stage 2 study. Information from prior IRP studies was incorporated where possible, and the Soil Survey for Macomb County was used to identify general surficial soil conditions. Geologic cross sections were prepared from available boring logs to show the subsurface geology at each site and to assess the relationships and spatial trends of geologic units at the base.

4.1.1.1 Surficial Soils

The predominant surficial soil at Selfridge ANGB is "made land." This soil represents the fill material added to the base to bring the generally low-lying land along the margin of Lake St. Clair to a level grade. Generally, natural soils have either been covered by fill operations or were excavated during the construction of base facilities. Fill material ranges in thickness from 5 to 10 feet where penetrated by borings at the IRP sites. The fill material encountered in the IRP Stage 2 borings consists of a mixture of sand, gravel, and clay.

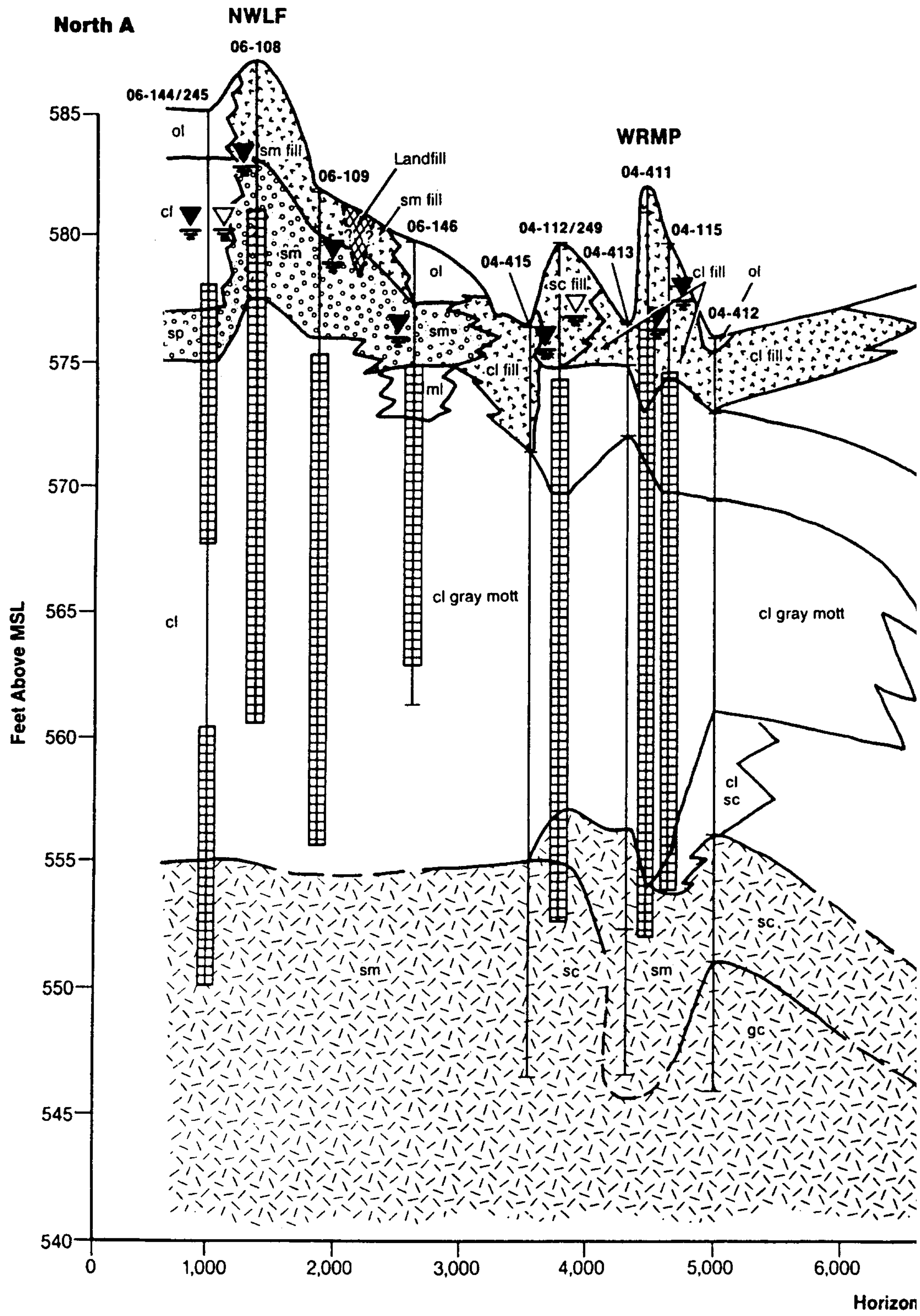
The natural soils mapped by the USDA Soil Survey are primarily confined to the peripheral areas of the base. These soils are defined using the characteristics of the uppermost 5 feet of material at any given location. Figure 2-5 shows the locations and types of soil found on base. The most commonly occurring natural soils are from the Paulding, Selfridge, and Toledo series. These soils are comprised of clay to sandy silt and typically are poorly drained. Under natural conditions, groundwater in these soils occurs at or near the land surface most of the year. These soils developed in the lacustrine, fluvial, and marshland sediments that were deposited in and along ancestral Lake St. Clair.

4.1.1.2 Subsurface Geology

The shallow subsurface geology at Selfridge ANGB and the area immediately around it has been influenced by its proximity to past and present lakes and rivers. Four basic stratigraphic units have been identified in the shallow subsurface geology at the base. These units are lacustrine clays, alluvial sands, beach sands, and glacial till. Deposition of the four units occurred during glaciation and deglaciation of the area and in response to the fluctuating levels of ancestral Lake St. Clair. Three generalized cross sections, Figures 4-1, 4-2, and 4-3, depict the extent and thickness of the various stratigraphic units and their relationships across the base. Figure 4-4 shows the locations and orientations of these cross-sections.

The lacustrine clays are the most common and extensive soil within the uppermost 35 to 40 feet of unconsolidated sediments penetrated by borings drilled during IRP Stage 2. These clays were deposited in a quiet-water setting in ancestral Lake St. Clair. The lacustrine clays are identified in the cross-sections by the USCS symbols cl and ml.

The upper part of the lacustrine clays consists of rusty brown to light brown, stiff, clay to silty clay with brown and reddish mottles, minor admixtures of sand, and some organic material. The lower part consists of olive gray to dark gray, plastic, clay to silty clay with gray mottling. At a given location, the contact between these materials coincides with the position of the water table. The characteristics of the upper material reflect a predominantly unsaturated condition that results in lower plasticity and that allows oxidation of soil minerals, whereas the characteristics of the lower material reflect saturated and chemically reduced conditions. Based on the slug tests performed during the IRP Stage 2 study, the permeability of the lacustrine clays ranges from 5.7×10^{-8} ft/sec (1.7×10^{-6} cm/sec) to 2.9×10^{-6} ft/sec (8.8×10^{-5} cm/sec) and averages about 1.0×10^{-6} ft/sec (3.0×10^{-5} cm/sec).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06-144/245
WRMP
04-411
06-109
Landfill
sm fill
06-146
04-112/249
04-115
04-415
04-413
sc fill
cl fill
ol
04-412
sp
sm
ml
cl
cl gray mott
cl
sc
sm
sc
gc
Feet Above MSL
585
580
575
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6,000
Horizon

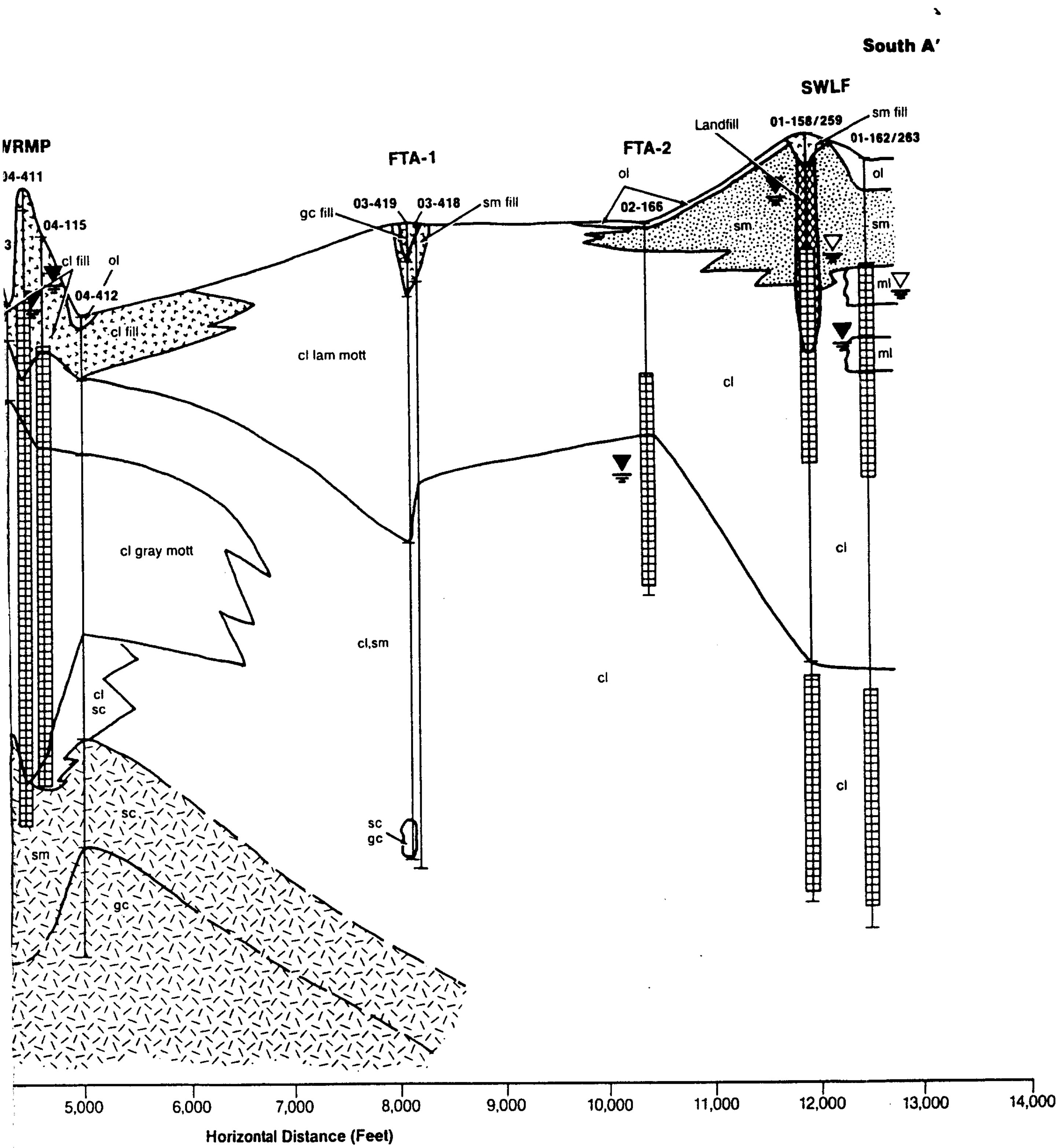


FIGURE 4-1 BA
CR

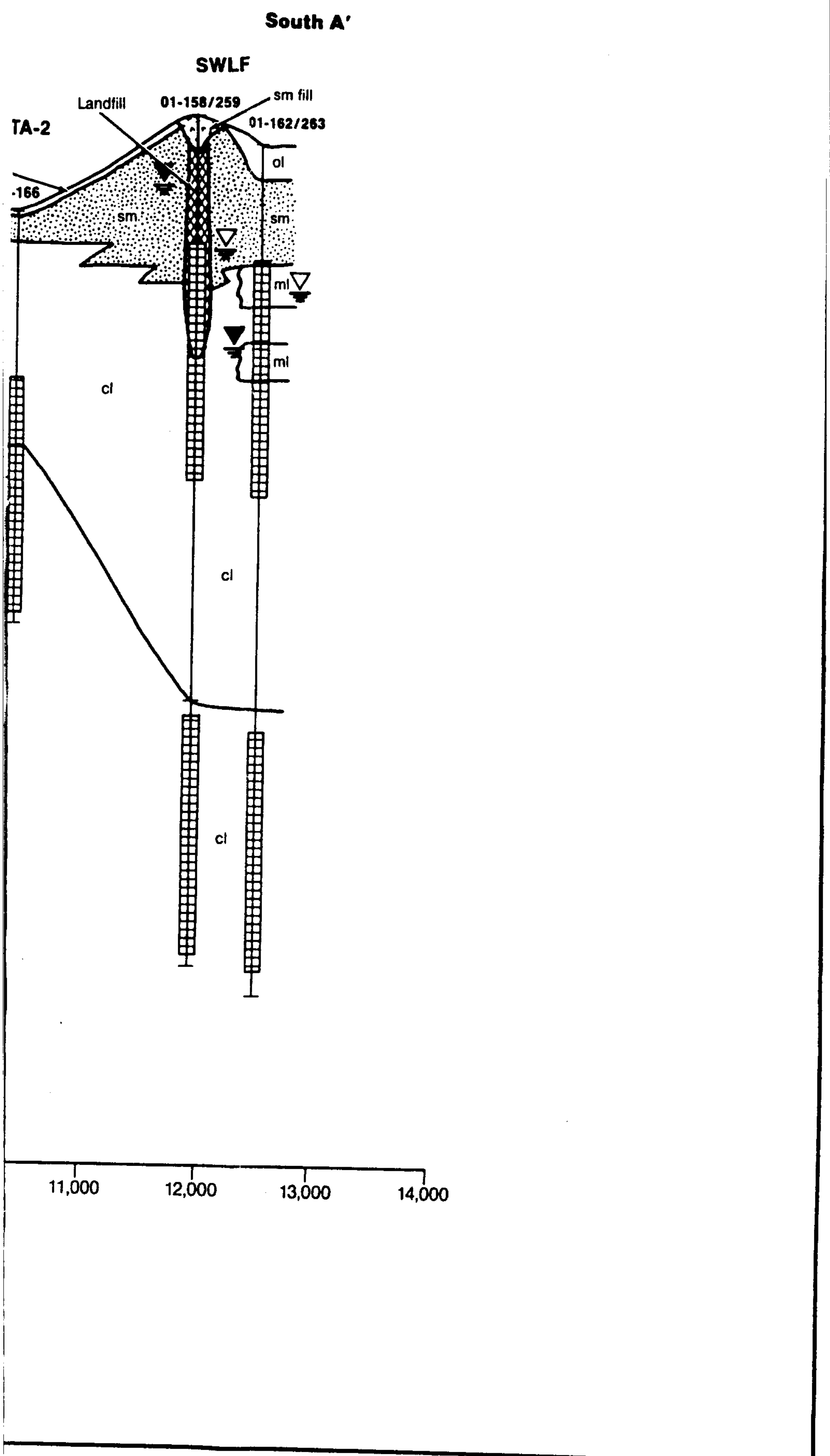
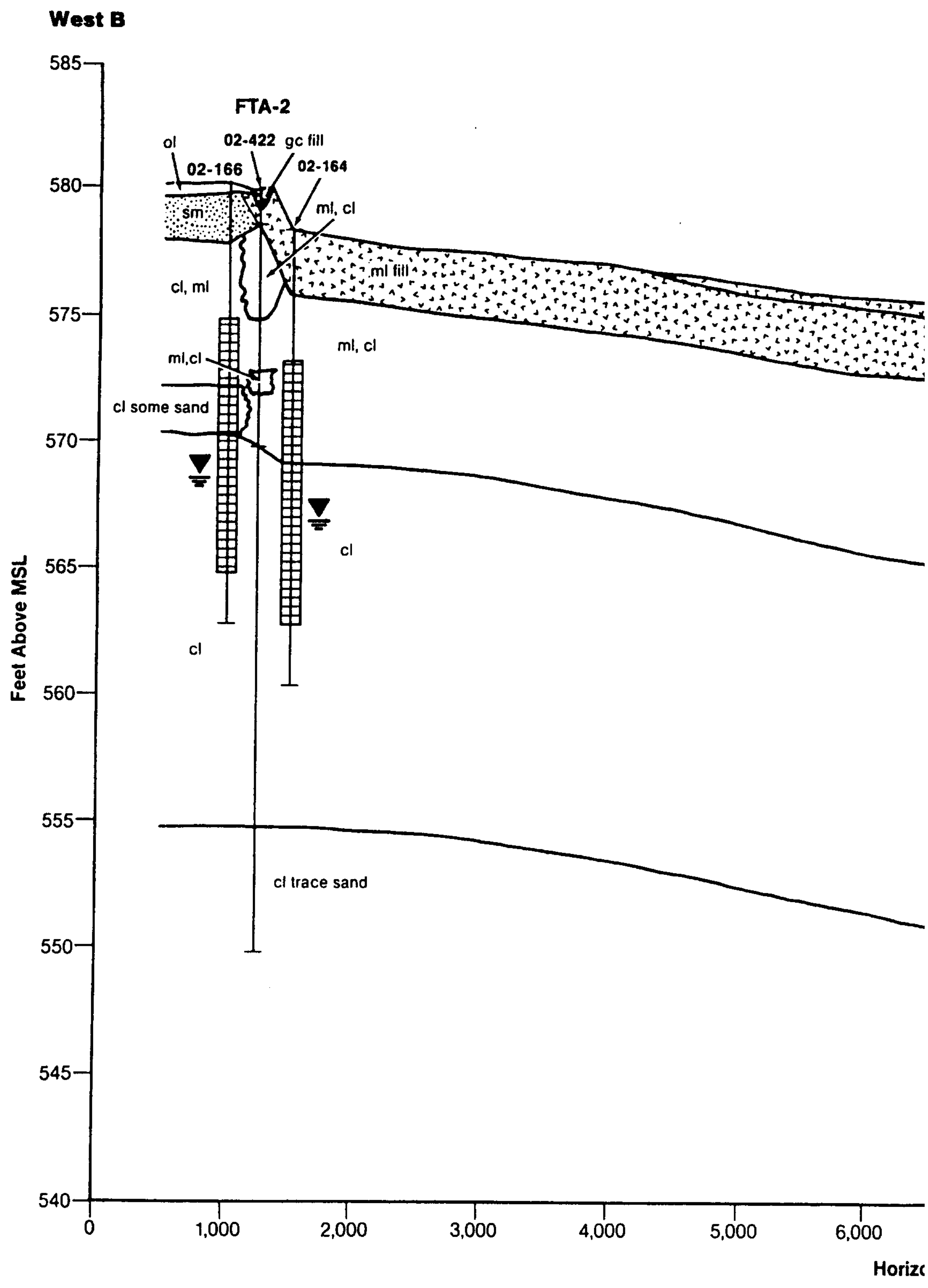
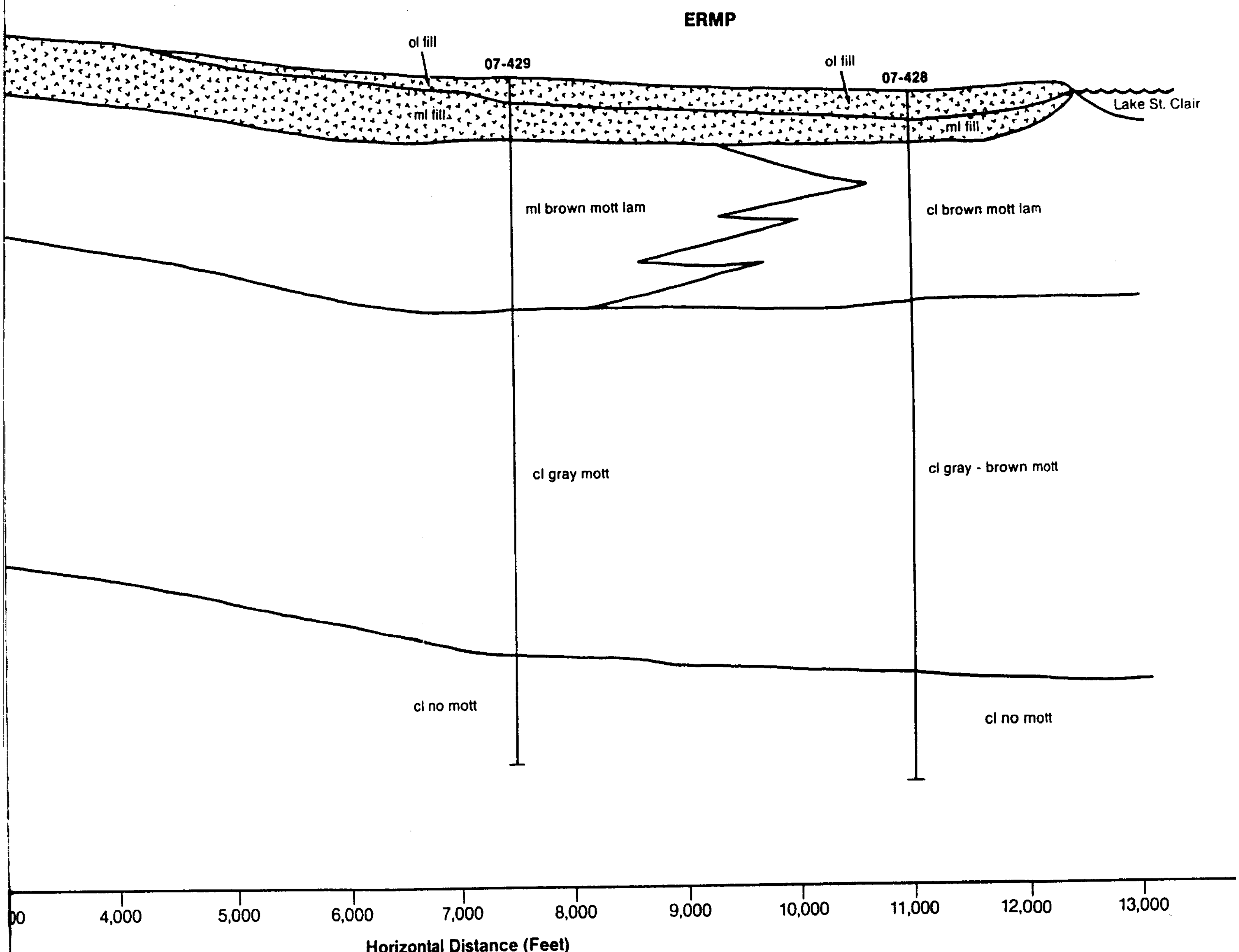


FIGURE 4-1 BASEWIDE GEOLOGIC CROSS SECTION A-A'



West B
FTA-2
02-422
gc fill
02-164
02-166
ol
sm
ml, cl
ml fill
cl, ml
ml,cl
cl some sand
ml, cl
cl
cl
cl trace sand
Feet Above MSL
585
580
575
570
565
560
555
550
545
540
0
1,000
2,000
3,000
4,000
5,000
6,000
Horiz

East B'



ERMP
ol fill
07-429
ol fill
07-428
ml fill
ml fill
Lake St. Clair
ml brown mott lam
cl brown mott lam
cl gray mott
cl gray - brown mott
cl no mott
cl no mott
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4,000
5,000
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7,000
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10,000
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13,000
Horizontal Distance (Feet)

FI

4-

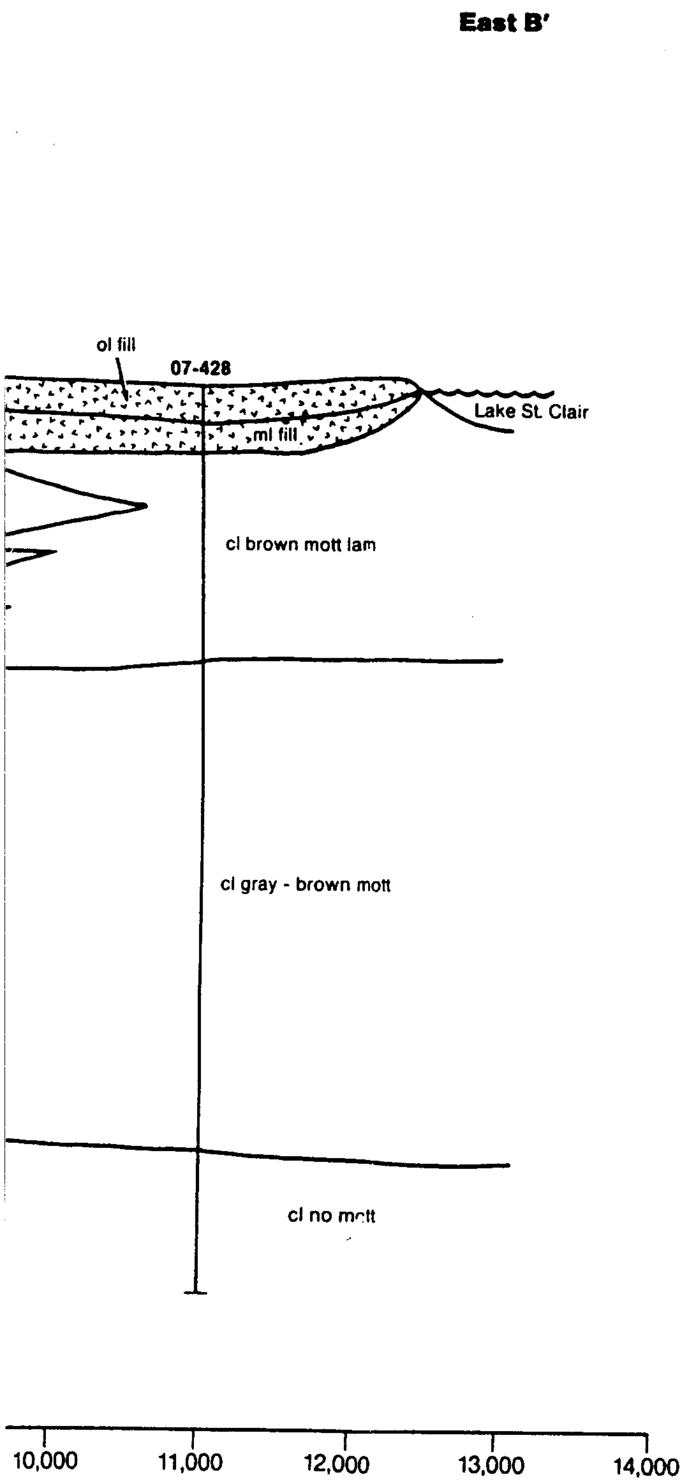


FIGURE 4-2 BASEWIDE GEOLOGIC CROSS SECTION B-B'

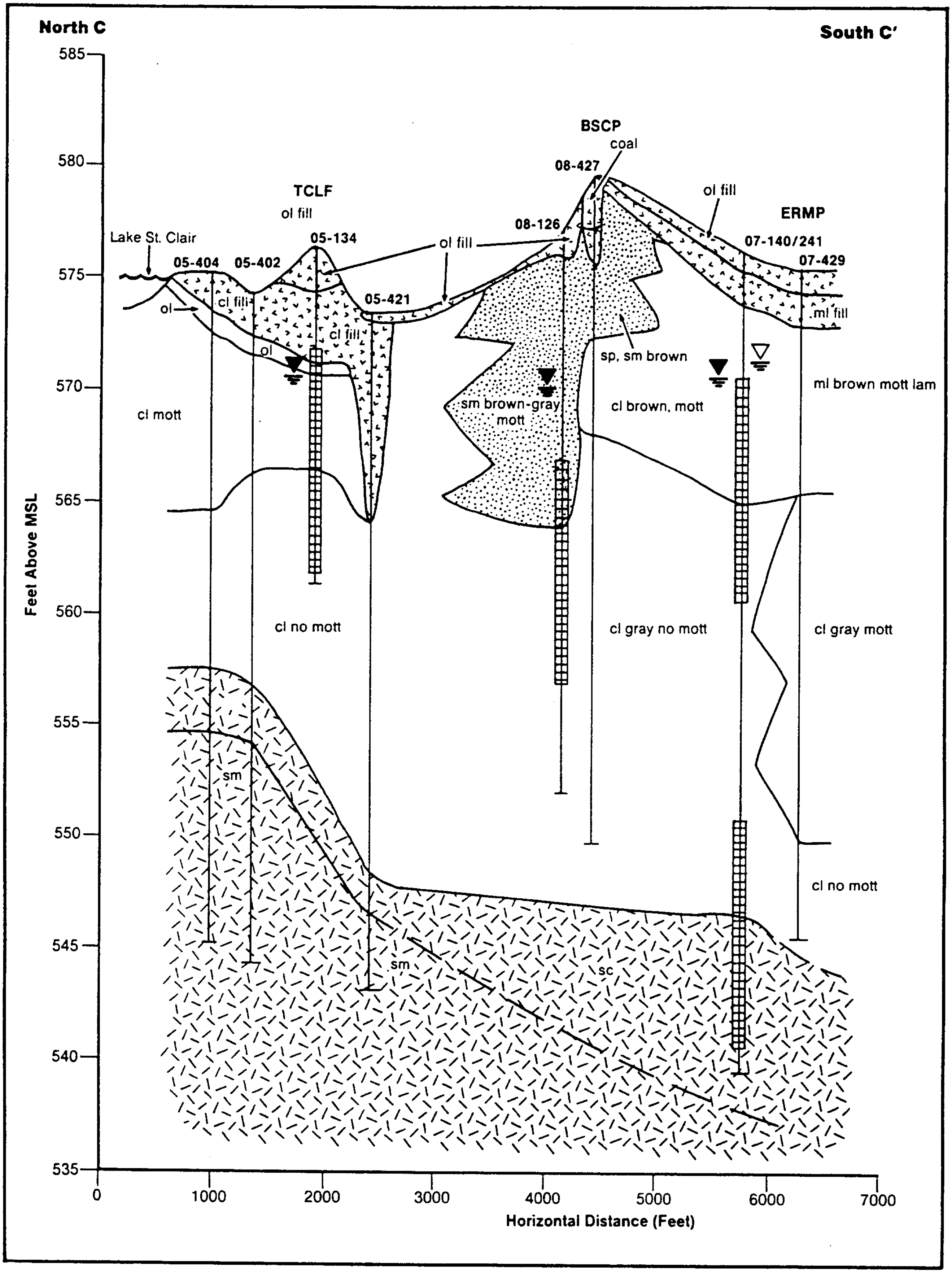
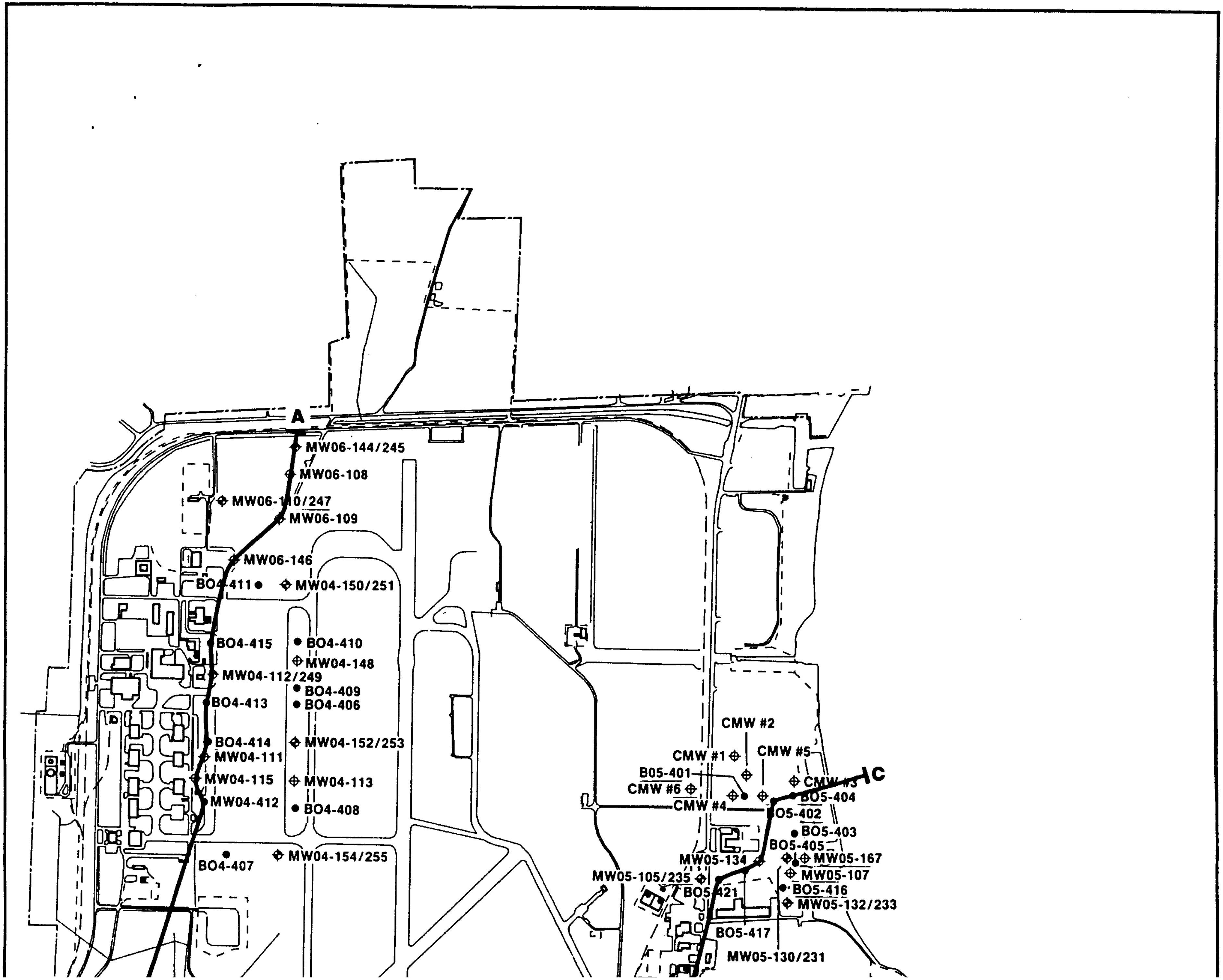


FIGURE 4-3 BASEWIDE GEOLOGIC CROSS SECTION C-C', SELFRIDGE, ANGB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MW06-146
BO4-411
MW04-150/251
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MW04-148
MW04-112/249
BO4-409
BO4-413
BO4-406
BO4-414
MW04-152/253
MW04-111
MW04-115
MW04-113
MW04-412
BO4-408
BO4-407
MW04-154/255
CMW #2
CMW #1
CMW #5
B05-401
CMW #3
C
CMW #6
BO5-404
CMW #4
BO5-402
BO5-403
BO5-405
MW05-134
MW05-167
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BO5-417
MW05-130/231

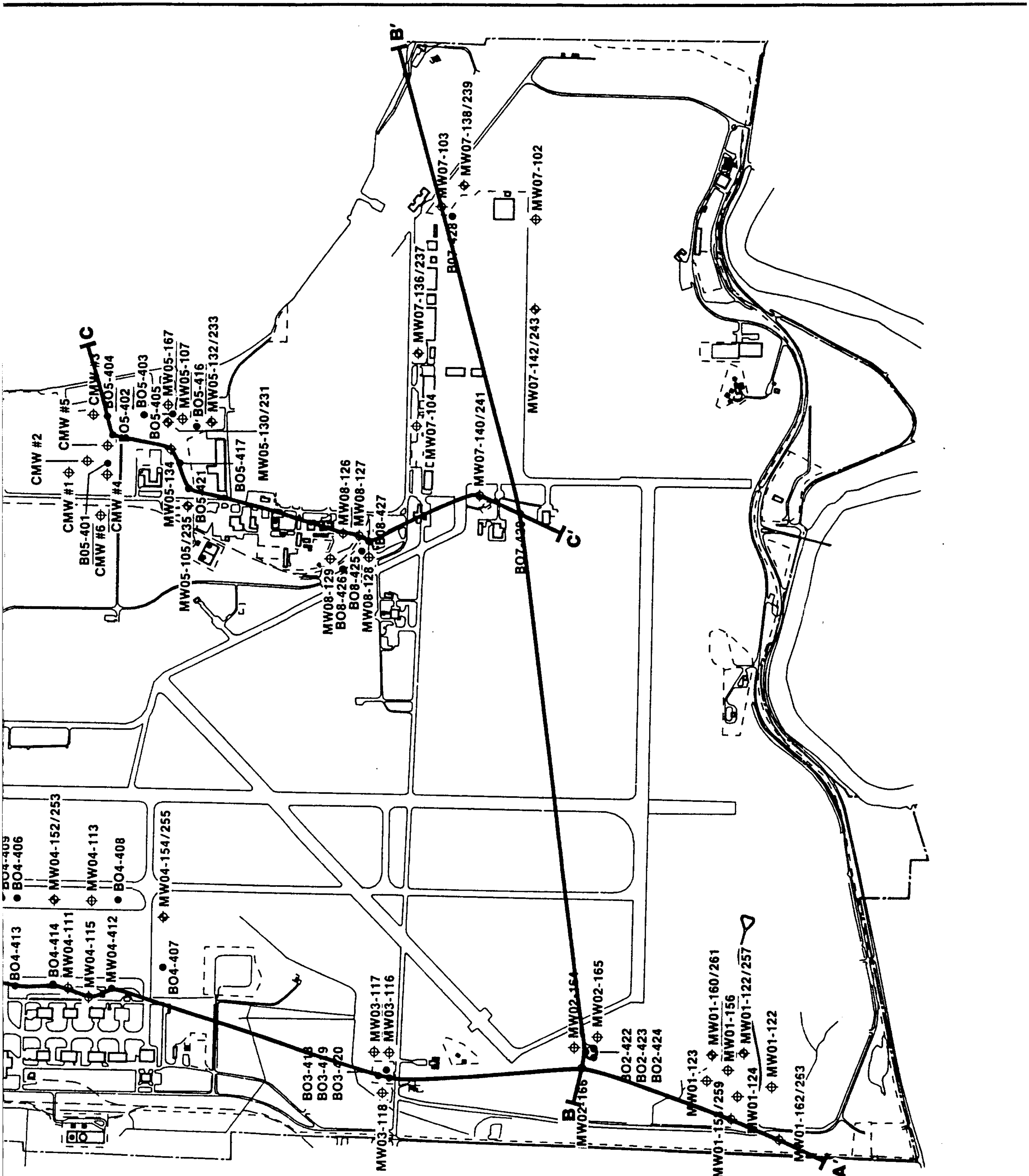

B'
C
C'
B
A'
CMW #1
CMW #2
CMW #4
CMW #5
CMW #6
BO5-401
BO5-402
BO5-403
BO5-404
BO5-405
BO5-416
BO5-417
MW05-105/235
MW05-107
MW05-130/231
MW05-132/233
MW05-134
MW05-167
MW08-126
MW08-127
MW08-128
MW08-129
BO8-425
BO8-426
BO8-427
MW07-102
MW07-103
MW07-104
MW07-136/237
MW07-138/239
MW07-140/241
MW07-142/243
BO4-406
BO4-407
BO4-408
BO4-412
BO4-413
BO4-414
MW04-111
MW04-113
MW04-115
MW04-152/253
MW04-154/255
MW03-116
MW03-117
MW03-118
BO2-422
BO2-423
BO2-424
MW02-165
MW01-122
MW01-123
MW01-124
MW01-156
MW01-160/261
MW01-122/257
MW01-162/253

FIGURE 4-4

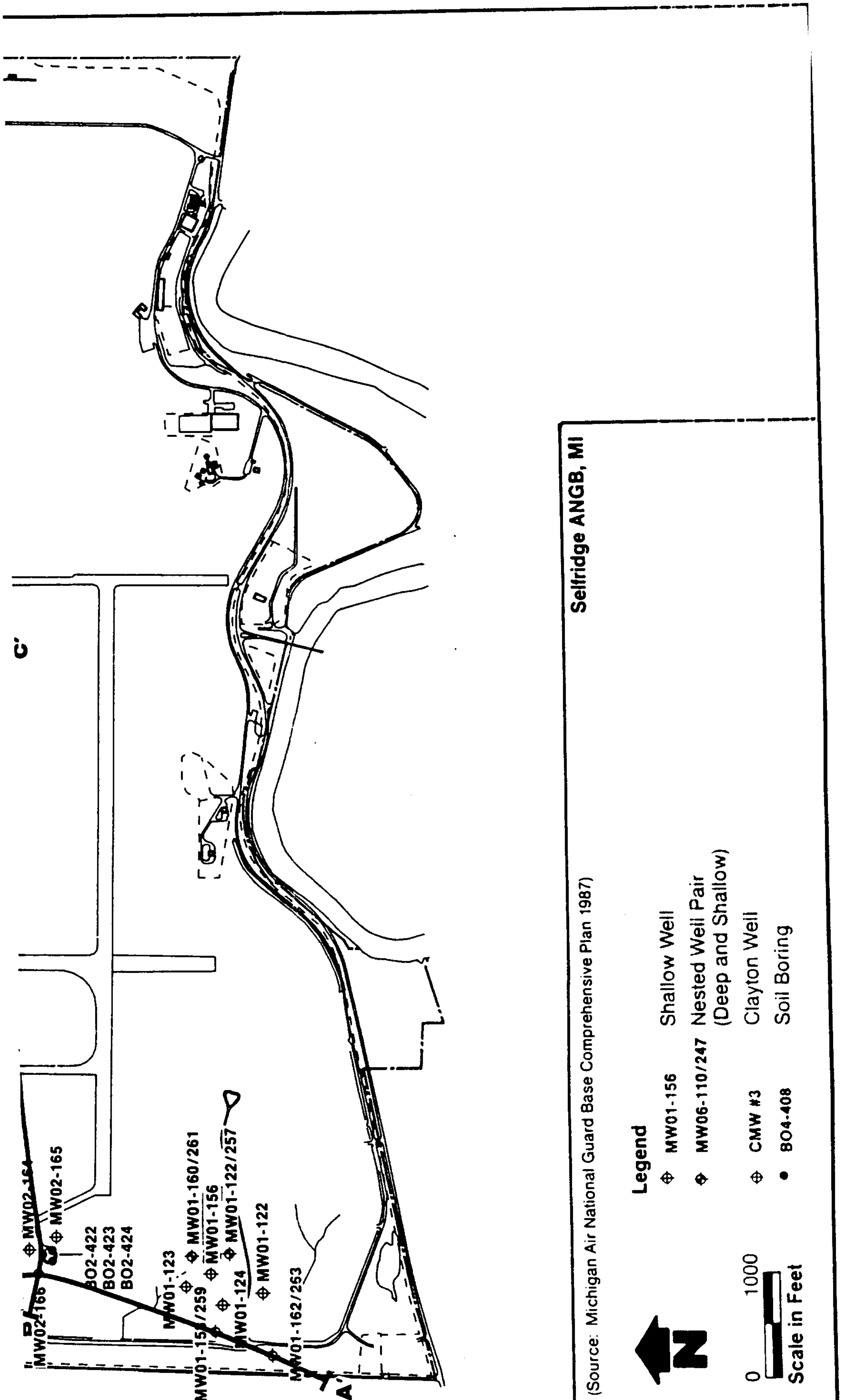


FIGURE 4-4 TRACE OF BASEWIDE CROSS SECTIONS A-A', B-B', AND C-C'

The lacustrine clays range from 15 to 30 feet in thickness throughout the base. Some sand and gravel lenses occur within the lacustrine clays. Although previous studies reported that these lenses could yield sufficient water for domestic use, the few sandy lenses encountered during IRP Stage 2 drilling were not of sufficient extent or thickness to warrant classification as an aquifer or to serve as an economical source of water.

Alluvial sands deposits are found in the southwestern corner of the base. The sands were probably deposited as channel sands or levee deposits by the ancestral Clinton River. The alluvial sands are identified in the cross sections by the USCS symbol sm.

The alluvial sands consist of light brown to brown, massive, fine-grained sand to silty sand. No slug test data are available for wells screened entirely in alluvial sands, but a permeability of 3.3×10^{-7} ft/sec (1.0×10^{-5} cm/sec) is a reasonable estimate based on their lithology.

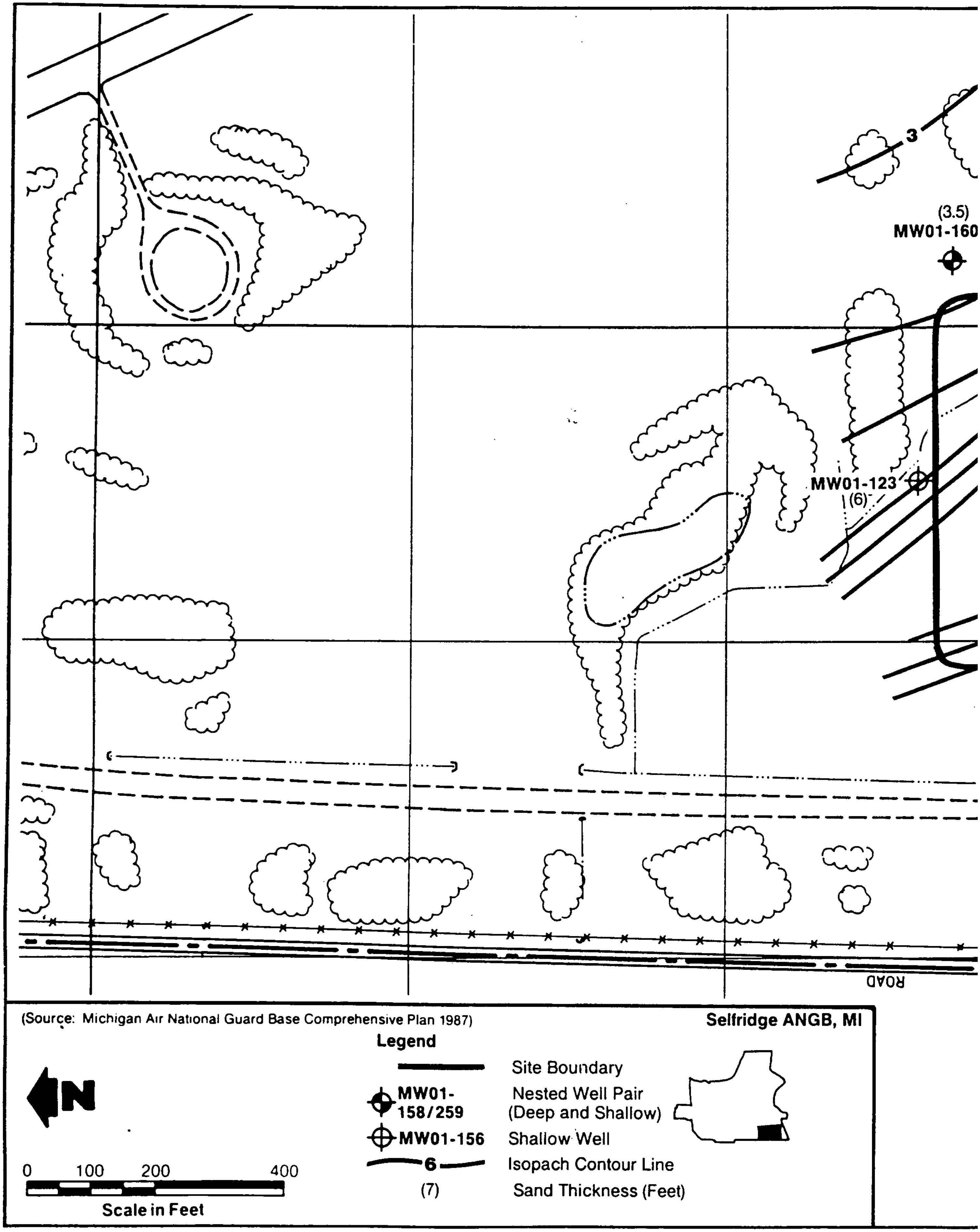
The alluvial sands layer is 0 to 10 feet thick at SWLF; it thins in the direction of FTA-2, where it was found at thicknesses of 0 to 2 feet; and it is absent at FTA-1, where no sand was encountered in the soil borings. The sands layer also decreases in thickness to the west of SWLF. An isopach map, Figure 4-5, shows the distribution of alluvial sands at SWLF.

The alluvial sands were excavated from a borrow pit at SWLF and used as fill material at the base. Figure 2-5 shows the location of this pit as mapped by the USDA Soil Survey. The borrow pit, which is located to the south of the area designated as SWLF by prior IRP studies, was apparently used to landfill various wastes.

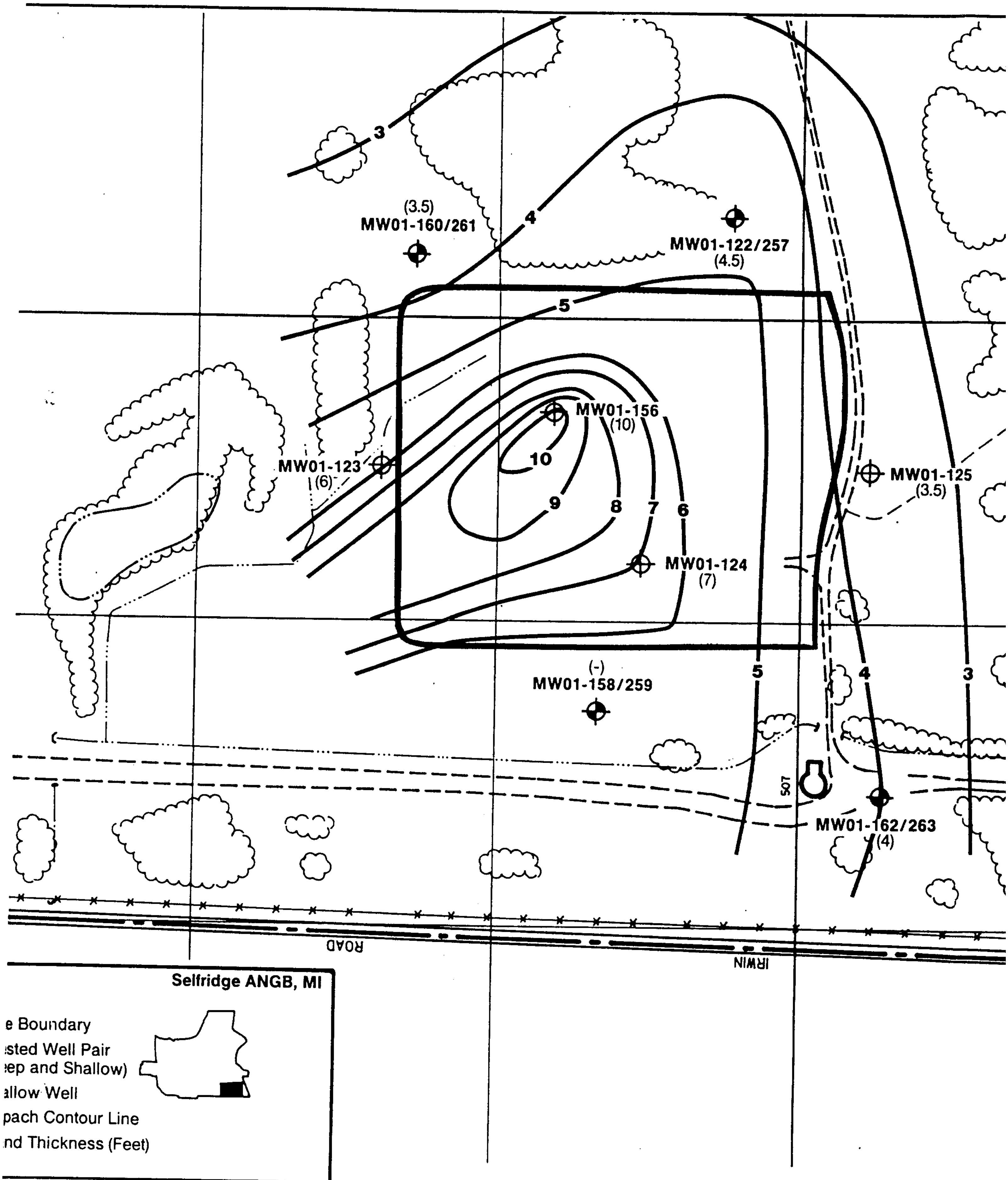
Beach sand deposits were found in the northwestern corner of the base. These sands were deposited at a former shoreline of ancestral Lake St. Clair. The beach sand is identified in the cross sections by the USCS symbols sp and sm.

The beach sand consists of olive brown to brown, massive, medium- to fine-grained sand with some silt. No slug test data are available for wells screened entirely in the beach sand, but a permeability of 3.3×10^{-6} ft/sec (1.0×10^{-4} cm/sec) is reasonable based on its lithology.

The beach sand unit ranged from 0 to 6 feet in thickness at NWLF. Figure 4-6 is an isopach map of beach sand thickness at this site based on data obtained during monitor well installation. The greatest thickness of sand occurred at monitor well location 06-108.



3
(3.5)
MW01-160
MW01-123
(6)
ROAD
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW01-158/259
Nested Well Pair (Deep and Shallow)
MW01-156
Shallow Well
6
Isopach Contour Line
(7)
Sand Thickness (Feet)
N
0
100
200
400
Scale in Feet


(3.5)
MW01-160/261
MW01-122/257
(4.5)
MW01-156
(10)
MW01-123
(6)
MW01-125
(3.5)
MW01-124
(7)
(-)
MW01-158/259
MW01-162/263
(4)
ROAD
IRWIN
Selfridge ANGB, MI
e Boundary
sted Well Pair
ep and Shallow)
allow Well
pach Contour Line
nd Thickness (Feet)

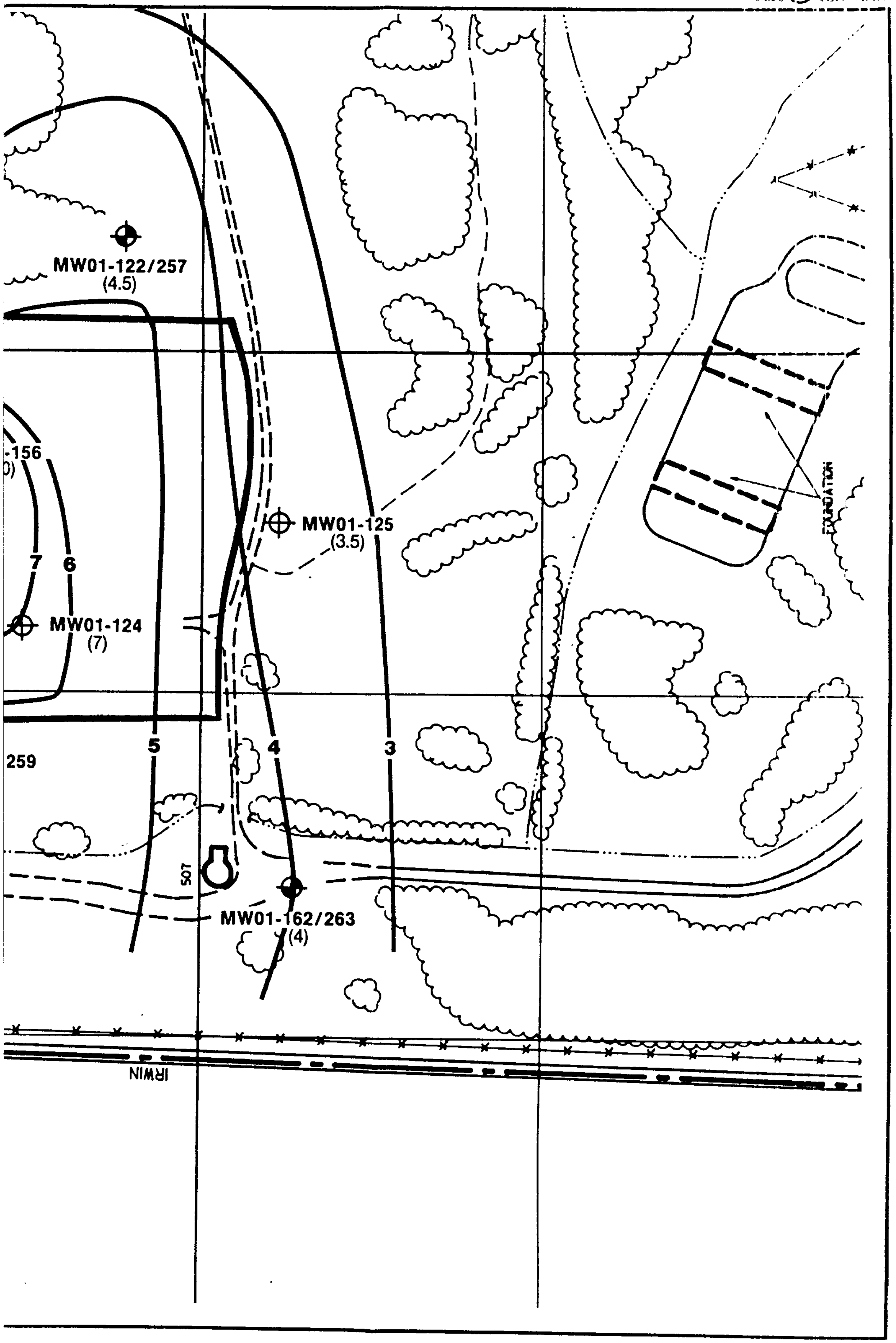
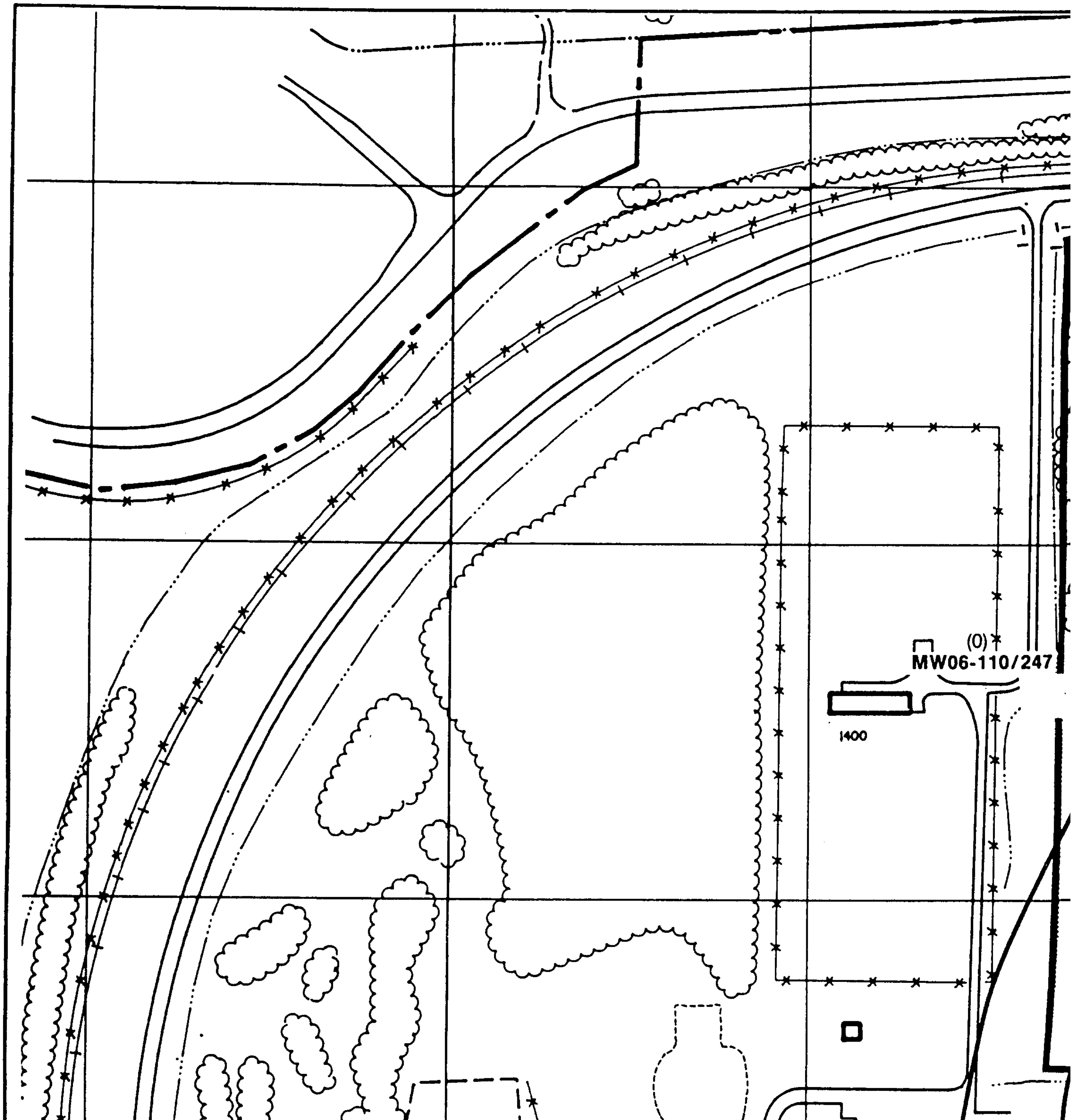


FIGURE 4-5 ISOPACH MAP OF SAND AT SWLF



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

(solid heavy line)	Site Boundary
MW06-144/245	Nested Well Pair (Shallow and Deep)
MW06-108	Shallow Well
2	Isopach Contour Line
(6)	Sand Thickness (Feet)

0 100 200 400

Scale in Feet

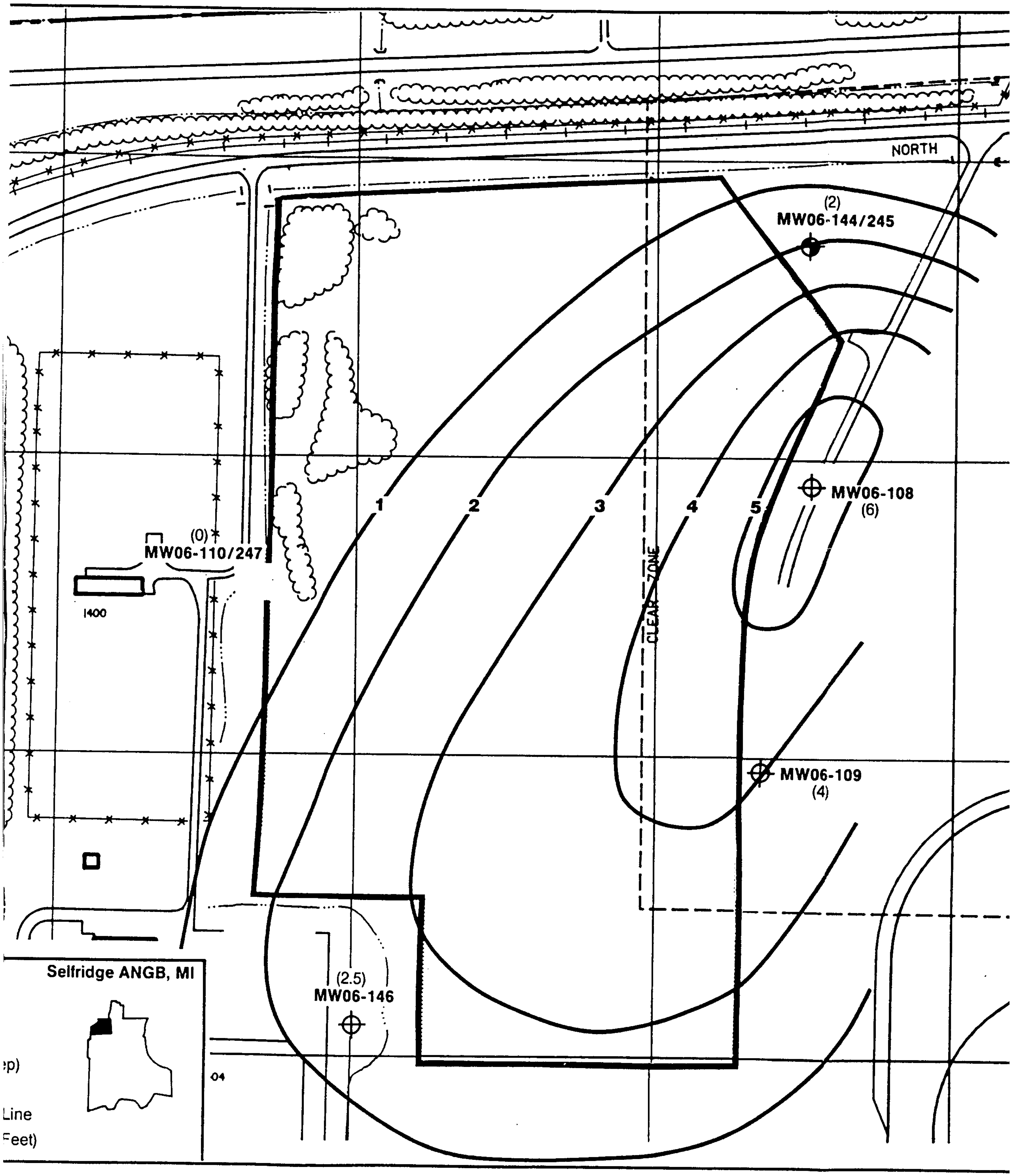


FIGURE 4-6 ISOP

4-9

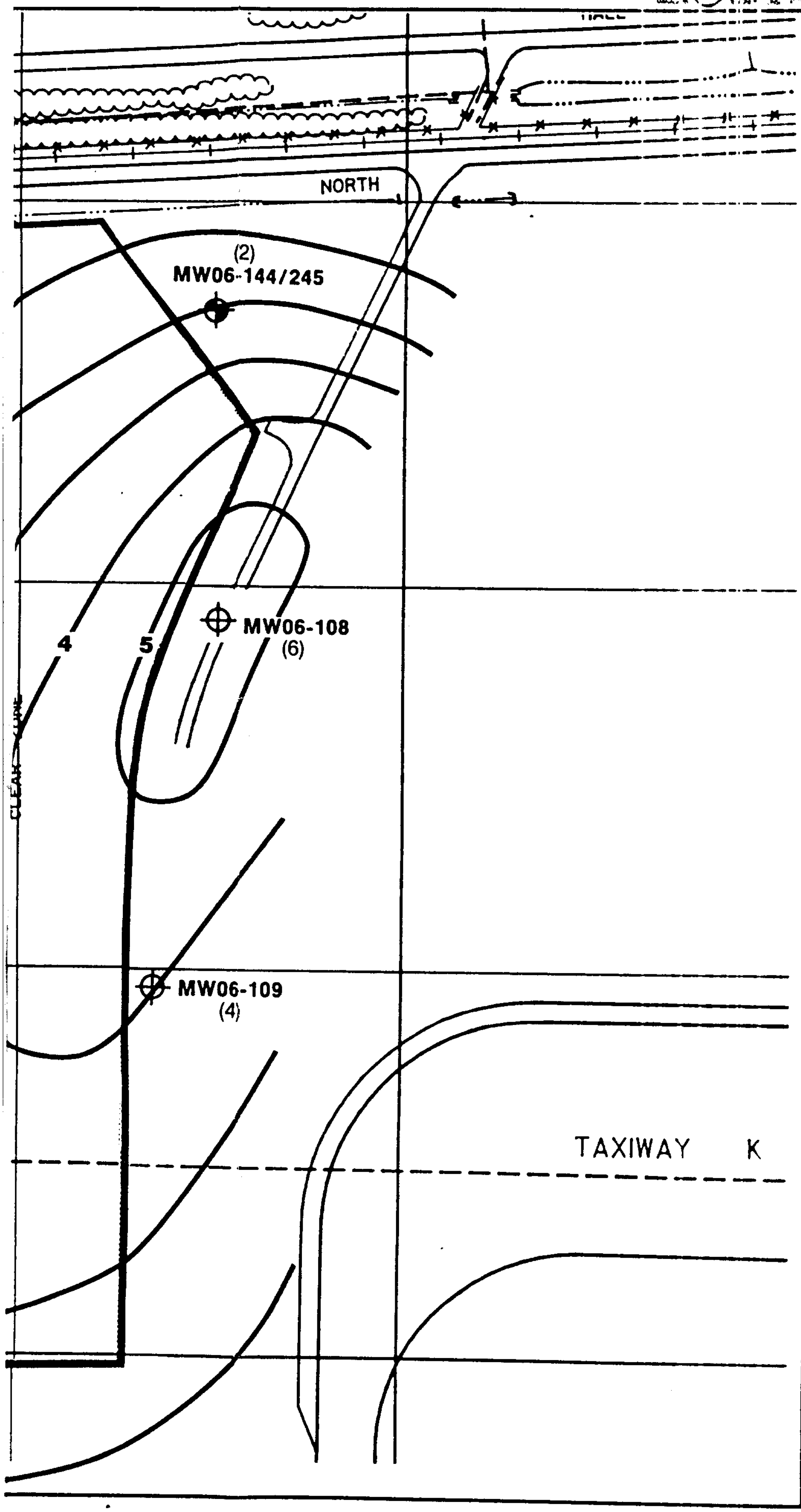


FIGURE 4-6 ISOPACH MAP OF SAND AT NWLF

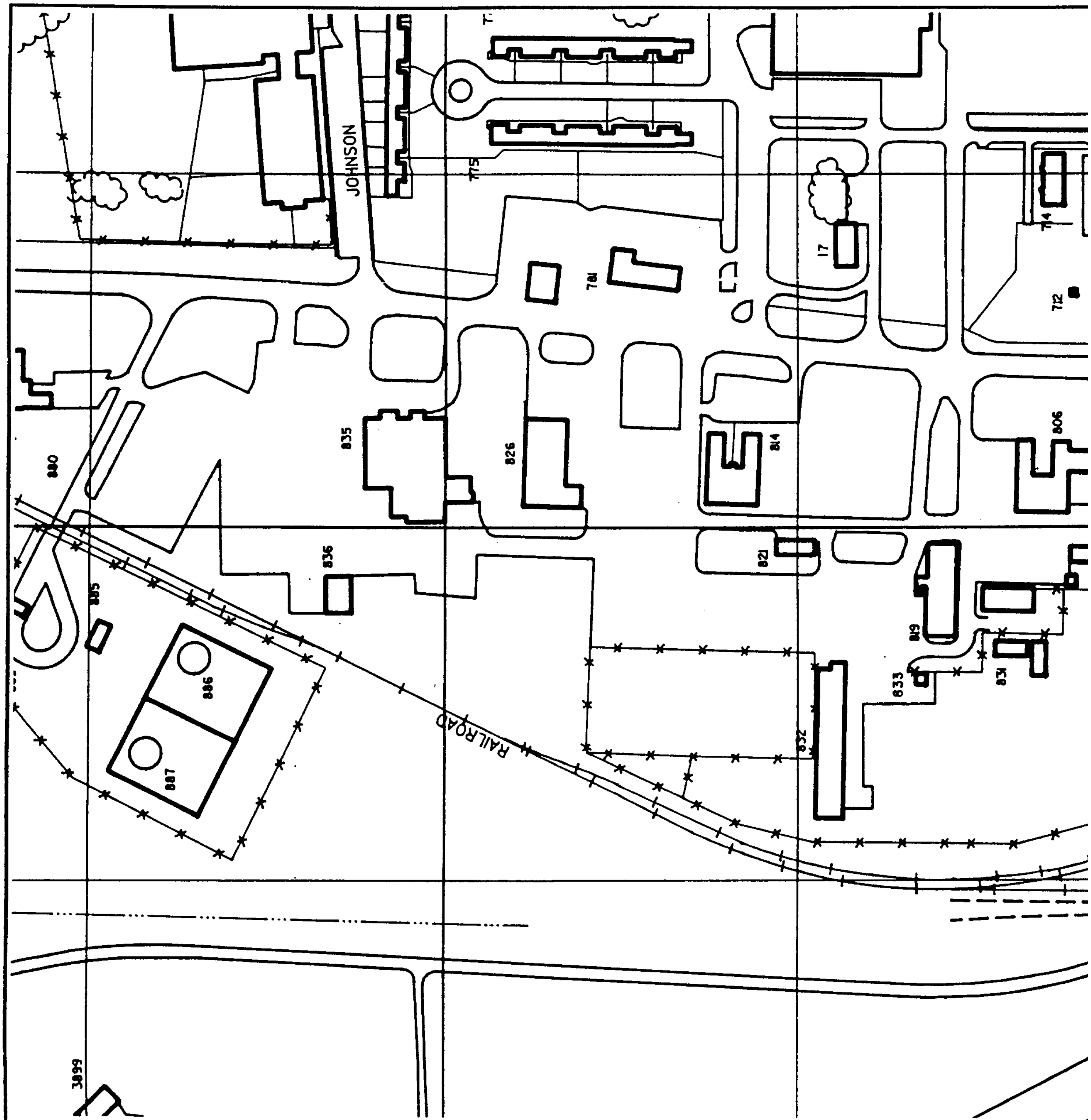
The beach sands were excavated from a borrow pit at NWLF and used as fill material at the base. Figure 2-5 shows the location of this pit as mapped by the USDA Soil Survey. The borrow pit, which is smaller than the area of NWLF as designated by prior IRP studies, was apparently used to landfill various wastes.

A sand deposit ranging in thickness between 1.5 and 9.5 feet was located during drilling at BCSP. The extent of this sand is shown in the isopach map in Figure 4-7. The depositional source of this sand body is unknown. Due to the relatively small size of this site, the areal extent of this sand is difficult to access. No IRP Stage 2 borings at TCLF or ERMP penetrated similar sand units of comparable thickness or depositional nature.

The IRP Phase I Report (ENCOTEC, 1983) included an isopach map of sands within 10 feet of the surface based on engineering borings across the base. In general, the ENCOTEC isopach map and those prepared using data from IRP Stage 2 studies are consistent, but there are some differences. In the vicinity of SWLF, the ENCOTEC map shows sand thicknesses increasing towards the Clinton River, whereas Figure 4-5 shows a thinning of the alluvial sand to the south and west. On the other hand, the IRP Stage 2 study found a greater thickness of alluvial sand at SWLF than reported by ENCOTEC. In the vicinity of NWLF, the ENCOTEC isopach map shows the beach sand deposit extending to the southwest beneath the buildings on the western side of WRMP, with sand thickness remaining relatively constant from northeast to southwest across the area. Near BCSP, the ENCOTEC isopach map shows a similar thickness of sand extending toward the northwestern corner of ERMP. The trend of this sand unit is from northwest to southeast.

The glacial till underlies the lacustrine clay unit throughout the base and was first encountered below a depth of approximately 25 feet. The till was probably deposited directly from glacial ice based on its high density and compact structure. Glacial till is identified in the cross sections by the USCS symbols sc and sm.

The till may be divided into an upper and lower unit, as shown in Figures 4-1 and 4-3. The upper till unit was comprised of a sand-clay mixture representing a transitional or reworked zone along the top of the till surface. Locally, a thin lens of coarse sand and gravel was encountered at this contact. The upper till unit ranges in thickness from 0 to 6 feet. The lower till unit consists of a dense sand and silt mixture. No borings installed during this IRP Stage 2 study or the previous IRP study penetrated more than a few feet of this lower till unit. Based on slug tests performed during the IRP Stage 2 study, the permeability of the till ranges from 1.1×10^{-7} ft/sec (3.4×10^{-6} cm/sec) to 8.7×10^{-7} ft/sec (2.6×10^{-5} cm/sec) and averages 5.3×10^{-7} ft/sec (1.6×10^{-5} cm/sec).



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

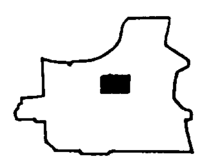
N

0 100 200 400

Scale in Feet

Legend

(line)	Site Boundary
MW08-126	Shallow Well
B08-426	Soil Boring
2	Isopach Contour Line
(3)	Sand Thickness (Feet)



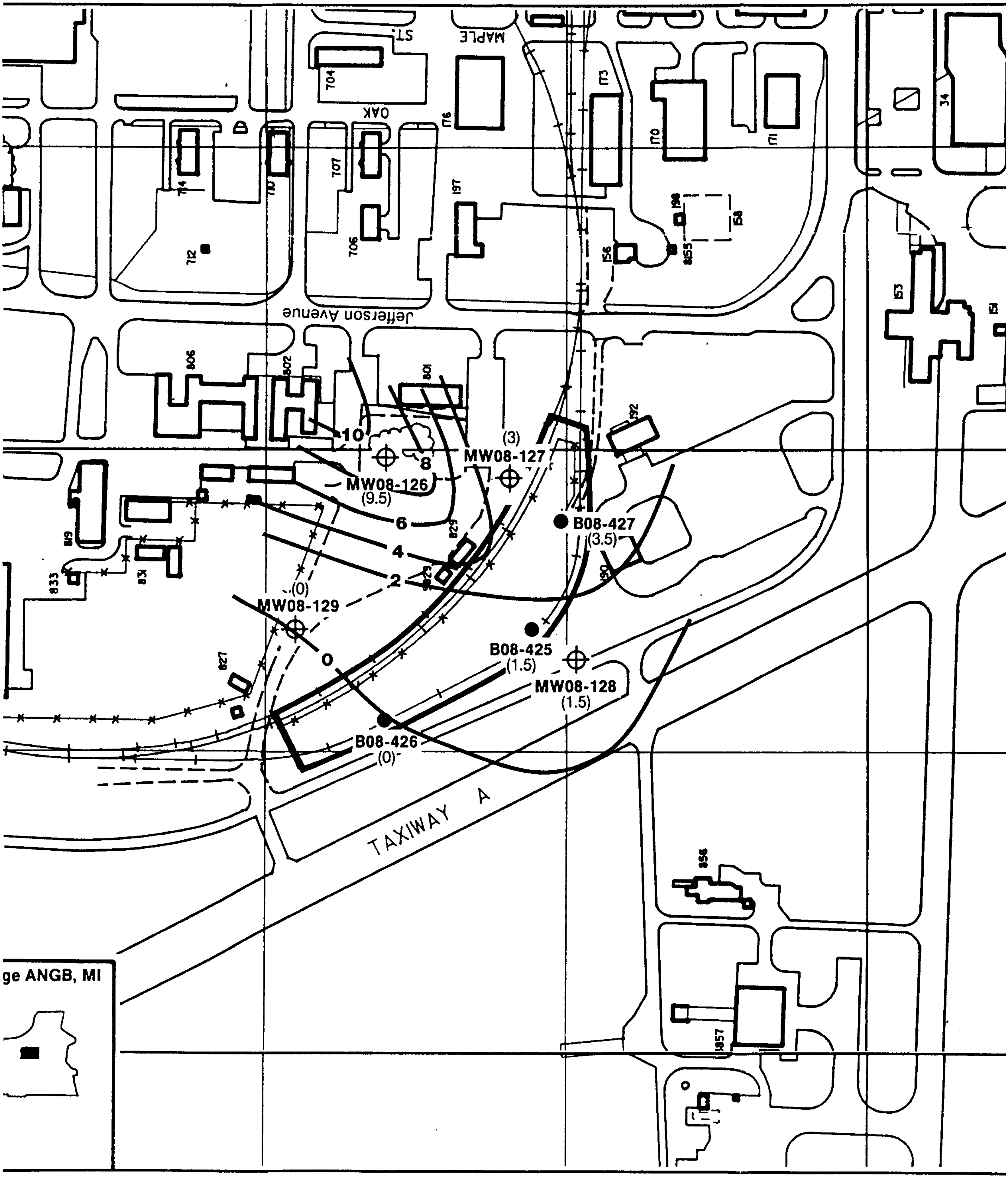


FIGURE 4-7 ISO
AT

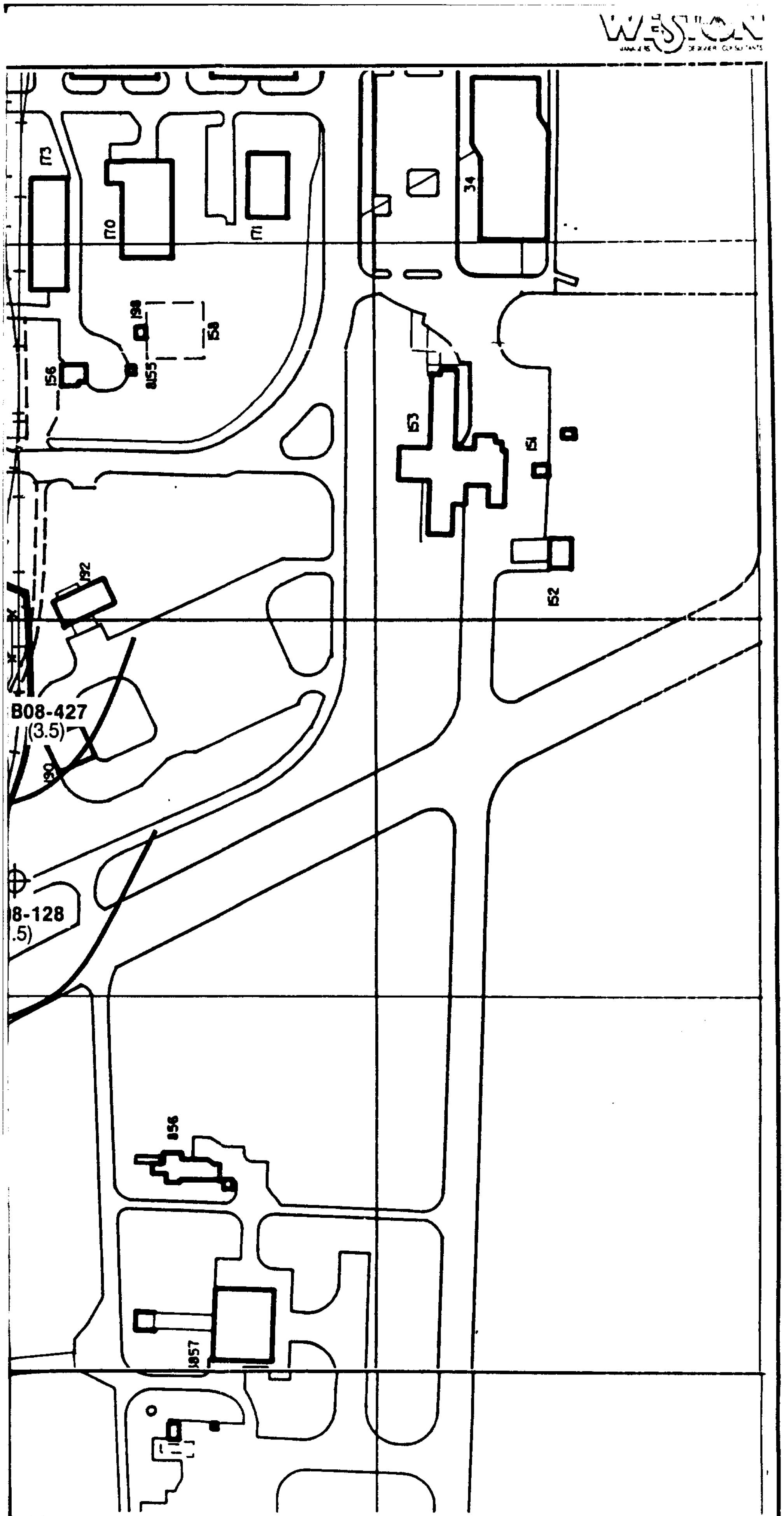


FIGURE 4-7 ISOPACH MAP OF SAND AT BCSP

As shown in Figure 4-8, the till surface slopes to the south and southeast. This sloping surface may represent the northern side of a valley eroded into the till by the ancestral Clinton River as it flowed into a post-glacial lake body to the east.

Bedrock, which lies below the glacial till, was not penetrated by boring activities conducted as a part of the IRP Stage 2 study. The bedrock surface is reported to occur at a depth greater than 70 feet below the surface of the base, according to the IRP Phase II Stage 1 study. Well logs for domestic wells provided by the Michigan Department of Natural Resources (see Appendix M) indicate that the uppermost bedrock unit is the Antrim Shale.

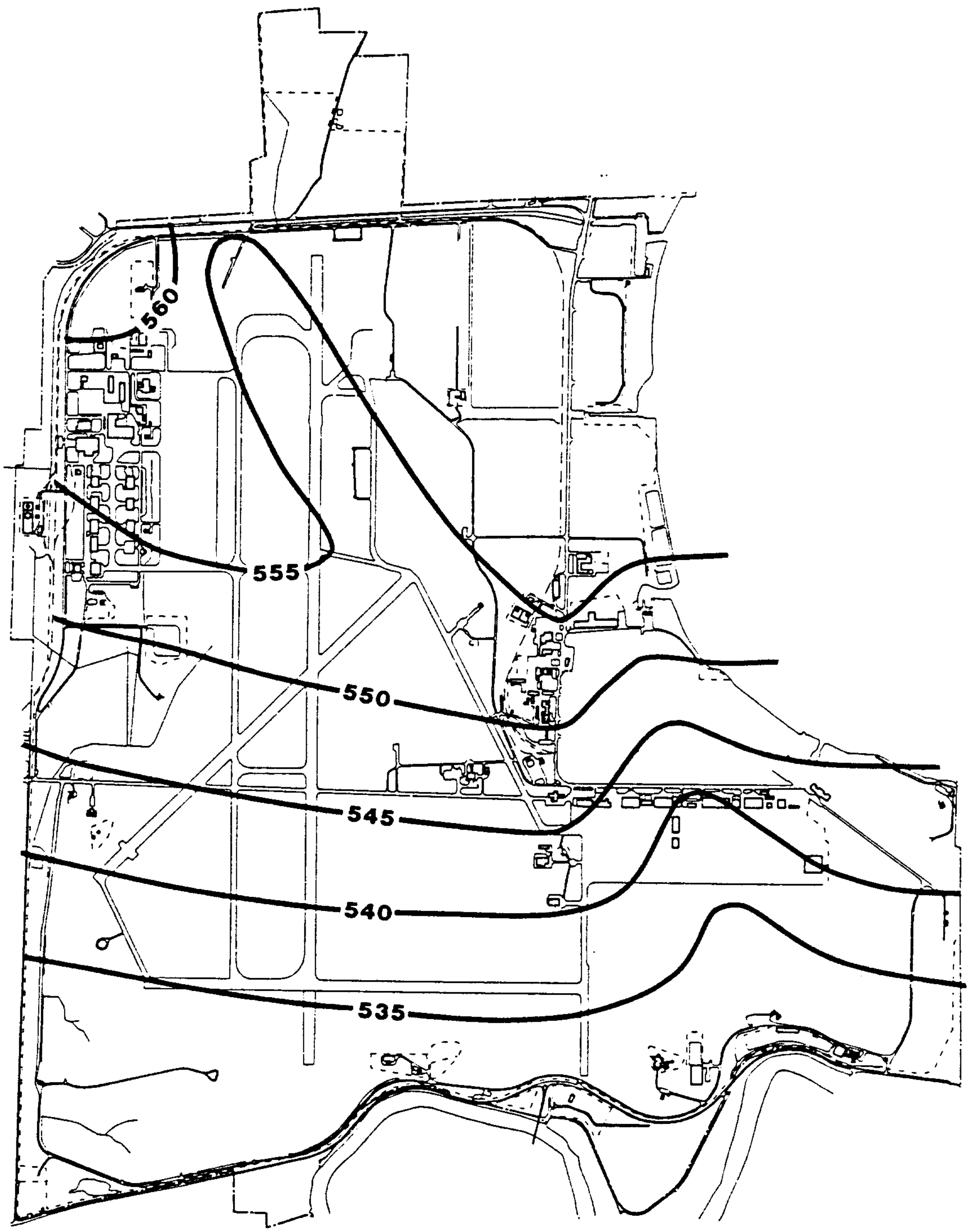
4.1.2 Groundwater Conditions

Groundwater data were collected from observations made during drilling activities and by measurement of water levels in the monitor wells on seven occasions between 1 February and 1 August 1988. Lake level elevation data for Lake St. Clair during the same time period were obtained from the National Oceanic and Atmospheric Administration (NOAA) for the St. Clair Shores gaging station.

4.1.2.1 Groundwater Occurrence

During installation of soil and monitor well borings at the base, the location of the water table was visually determined based on the presence of saturated conditions and mottling changes in the soil. The presence or relative absence of water in a soil results in either oxidation or reduction of iron-containing minerals to produce mottled horizons. In the unsaturated zone, mottling appears as a brown to rusty brown pattern in the soils. Soils in this horizon were dry to moist. The position of the water table in a particular boring was determined by the transition to gray mottled soils, which were wet to saturated. The gray mottling is a result of reduction due to the anaerobic conditions below the water table. The change in mottling was observed during drilling to occur at a depth of 8 to 15 feet below the land surface. This boundary was generally found within undisturbed natural soil.

Following installation of the monitor wells, the water level inside the monitor well was observed to be higher than the estimated position of the water table observed in the soils. This phenomenon occurred throughout the base. No fully satisfactory explanation of this phenomenon was arrived at during this study. However, the lack of a clear explanation does not affect the useability of the water level data or the conclusions drawn from them because the effect occurred throughout the base and the data still represent valid hydrostatic head information for a common depth within a single hydrostratigraphic unit.



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

0 1000

Scale in Feet

Legend

—550— Contour Line

FIGURE 4-8 TOPOGRAPHY OF GLACIAL TILL SURFACE AT SELFRIDGE ANGB

Two distinct seasonal fluctuation trends can be seen in water level data from the monitor wells. These trends are a general increase during the winter to spring period and a general decrease from spring through the end of summer. These trends show a good correlation with the amount of precipitation received during these periods (see Figure 4-9). The general increase in water levels basewide corresponds with ground thawing and receipt of spring rains. Some of the observed increase may also be attributed to the water levels moving toward a condition of equilibrium with the local groundwater conditions following monitor well installation. The general decline in water levels corresponds with the period of near-drought conditions experienced in 1988. Figures 4-10 through 4-12 show hydrographs for selected monitor wells at the IRP sites.

The water surface elevation of Lake St. Clair showed trends similar to the monitor well water level data. For the period of interest, the lake level ranged from a low of 574.19 feet above MSL in March 1988, to a high of 574.66 feet above MSL in May 1988, and back down to a low of 573.86 feet above MSL in August 1988.

4.1.2.2 Groundwater Flow Directions

Groundwater potentiometric surface maps were constructed using measured water level elevation data. Basewide potentiometric maps for shallow and deep monitor wells on 1 August 1988 are shown in Figures 4-13 and 4-14. Site-specific potentiometric maps are presented in Subsections 4.4 through 4.11. Basewide, the groundwater flow direction for both shallow and deep monitor wells is generally eastward toward Lake St. Clair. However, both Figures 4-13 and 4-14 show the presence of a closed depression adjacent to Lake St. Clair having water level elevations lower than the lake level. This indicates that groundwater at the base is not discharging directly to the lake and that water in the lake is recharging groundwater beneath the base. The closed depressions also require the presence of some other discharge mechanism. The stormwater drainage system is believed to be this mechanism.

Although the majority of the stormwater drainage system was not designed to remove groundwater from the base, construction imperfections and material deterioration have apparently provided a means for this to occur. When considered on a short-term basis, the effectiveness of groundwater interception by the stormwater system is probably not very significant at any given point along the system. However, for the system as a whole, over more than 50 years of operation, the combination of an extensive drainage system with drainage tiles and leaky pipes and rapid removal of water compared to a slow recharge rate have produced a clear effect on the groundwater at the base.

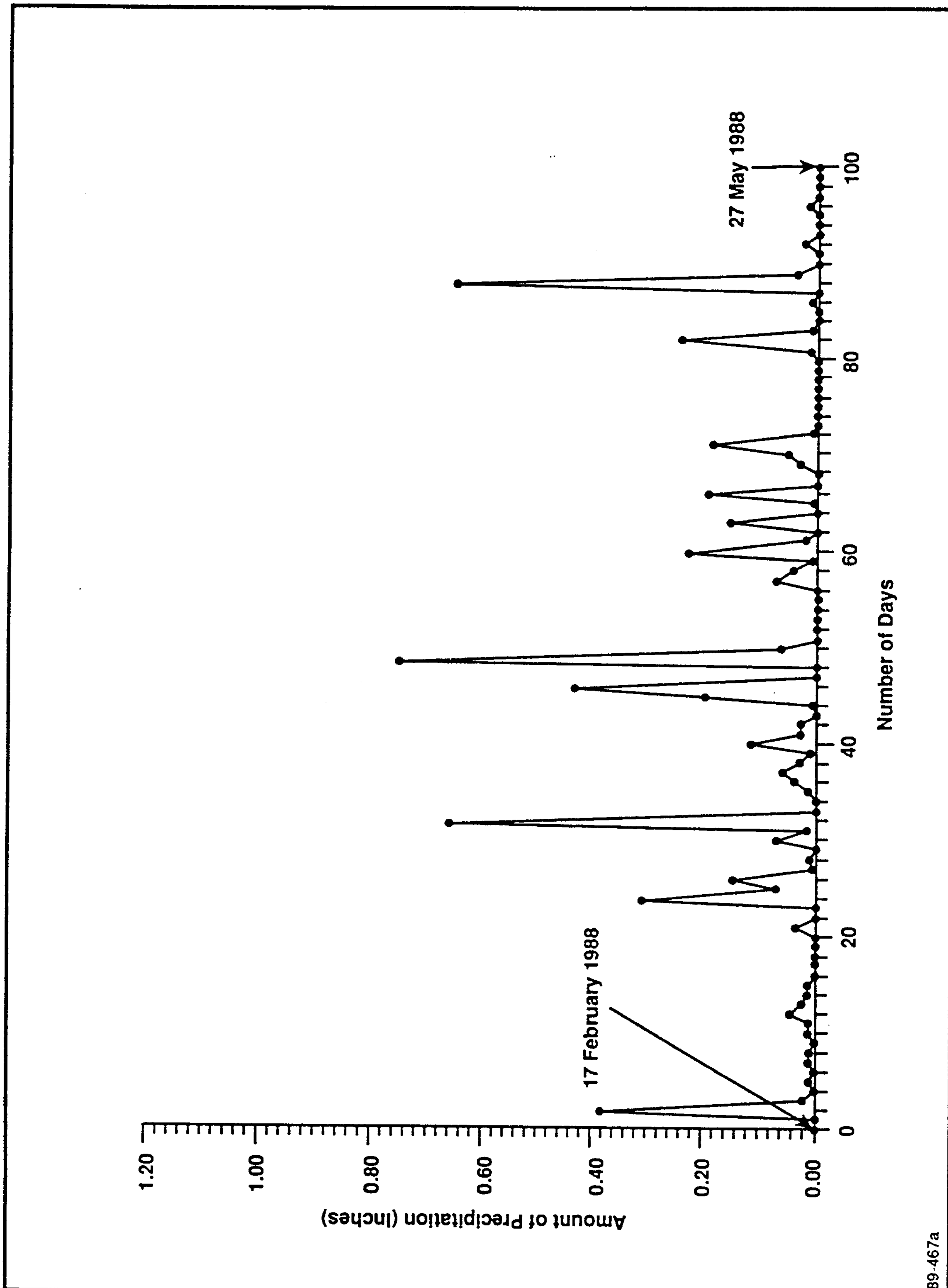


FIGURE 4-9 DAILY AMOUNTS OF PRECIPITATION RECEIVED DURING THE OPERATION OF THE CONTINUOUS WATER LEVEL RECORDER STATIONS

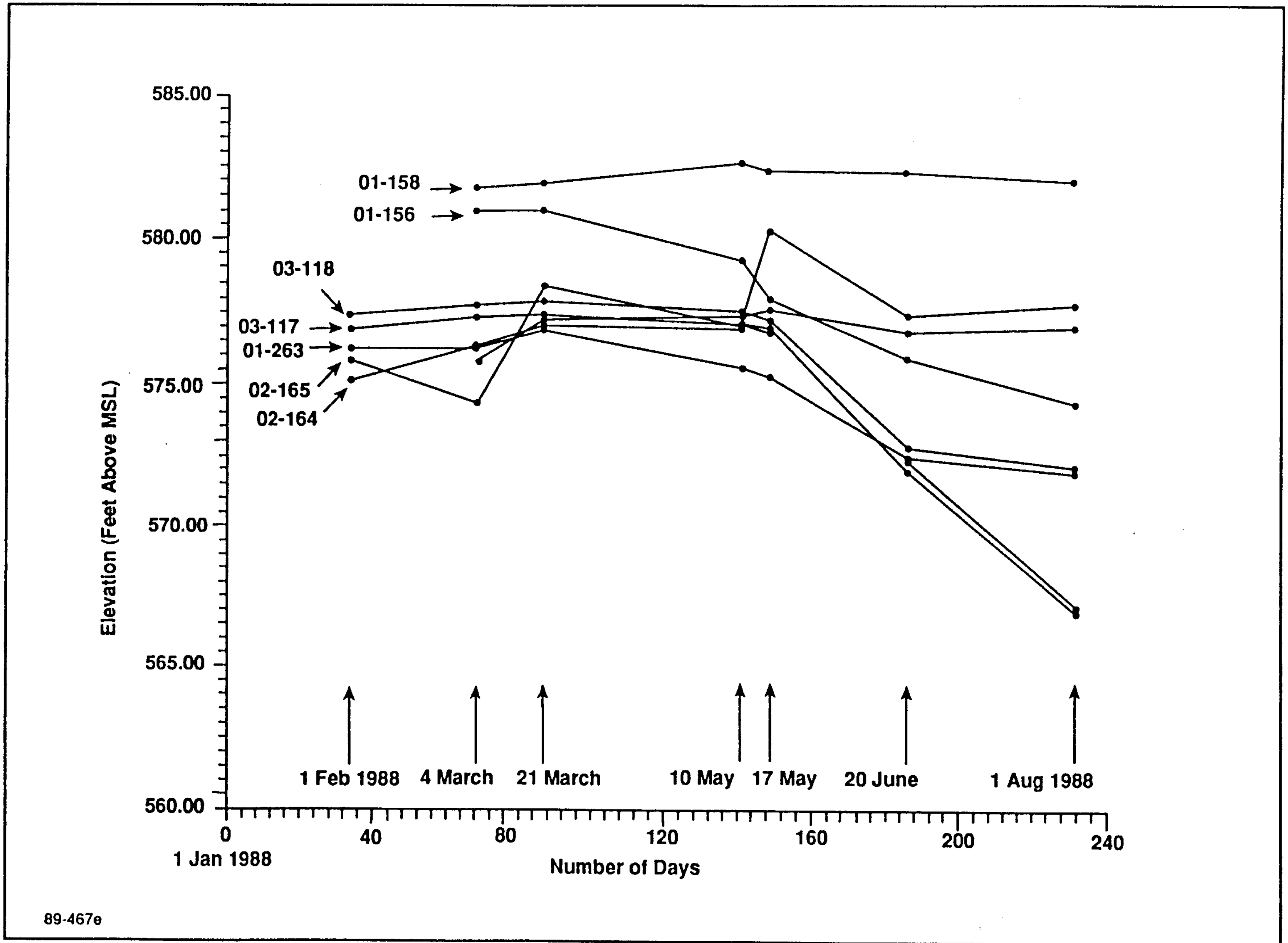


FIGURE 4-10 HYDROGRAPHS FOR SELECTED MONITOR WELLS IN THE SOUTHWESTERN PORTION OF THE BASE

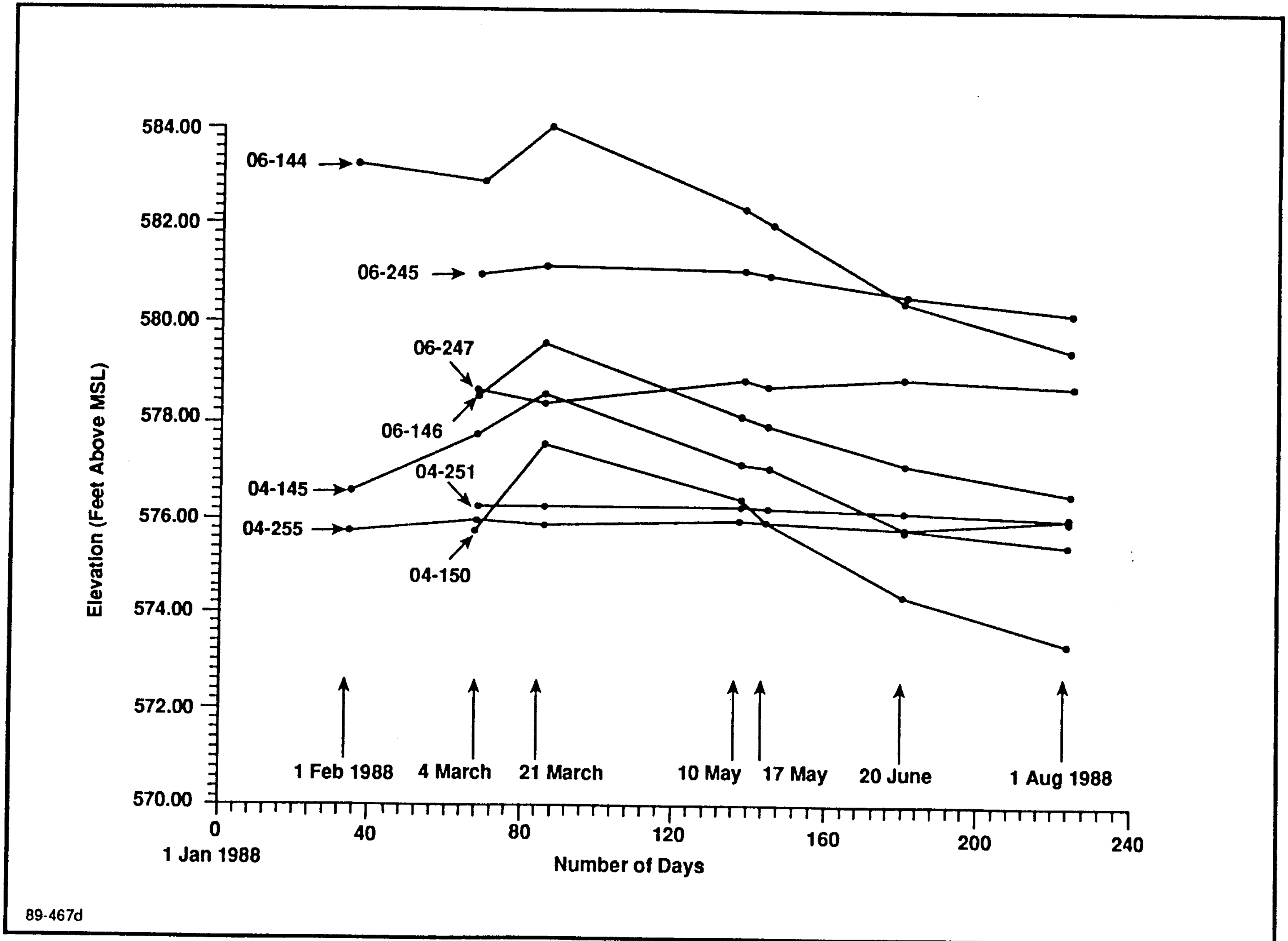


FIGURE 4-11 HYDROGRAPHS FOR SELECTED MONITOR WELLS IN THE NORTHWESTERN PORTION OF THE BASE

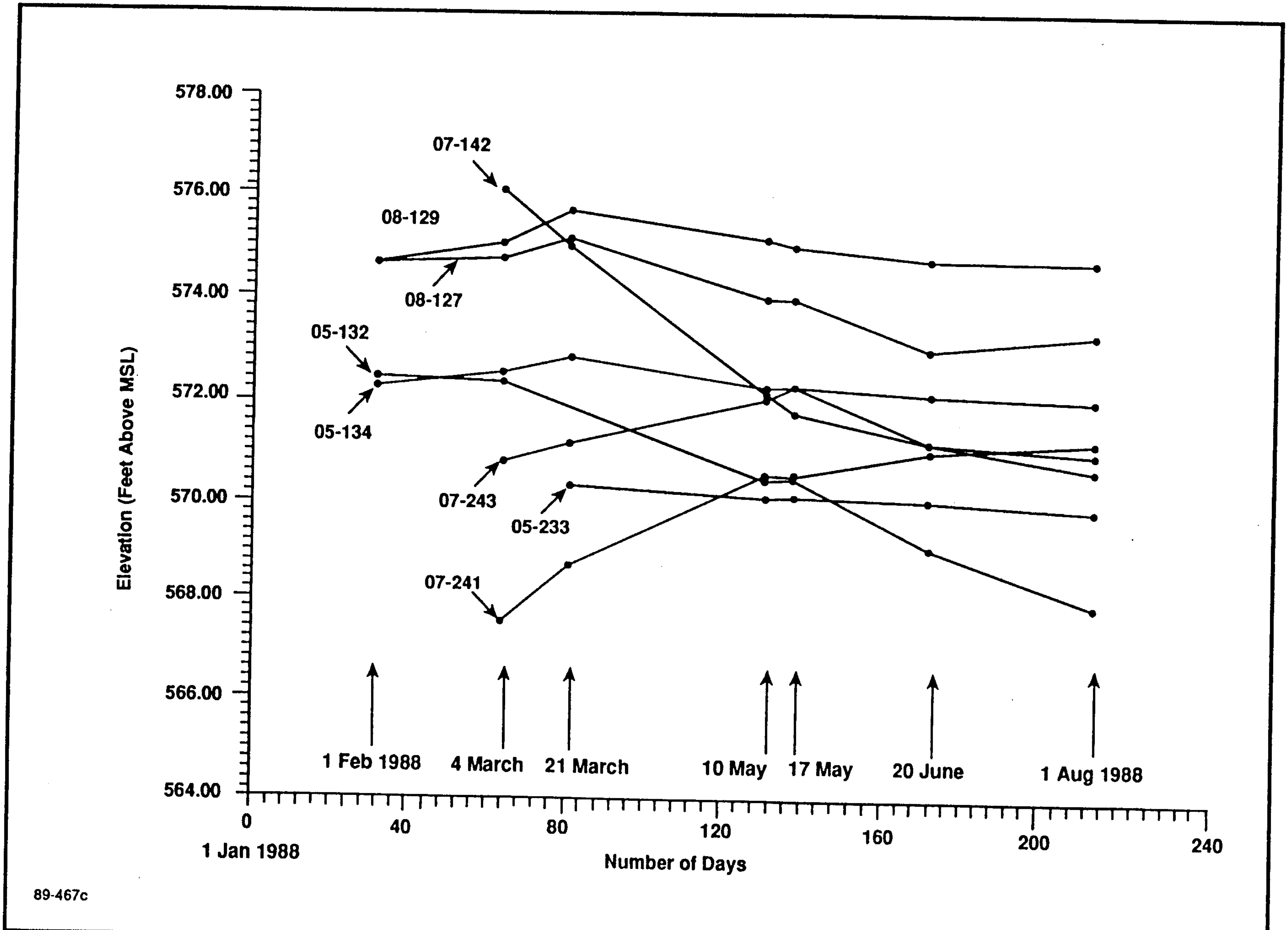
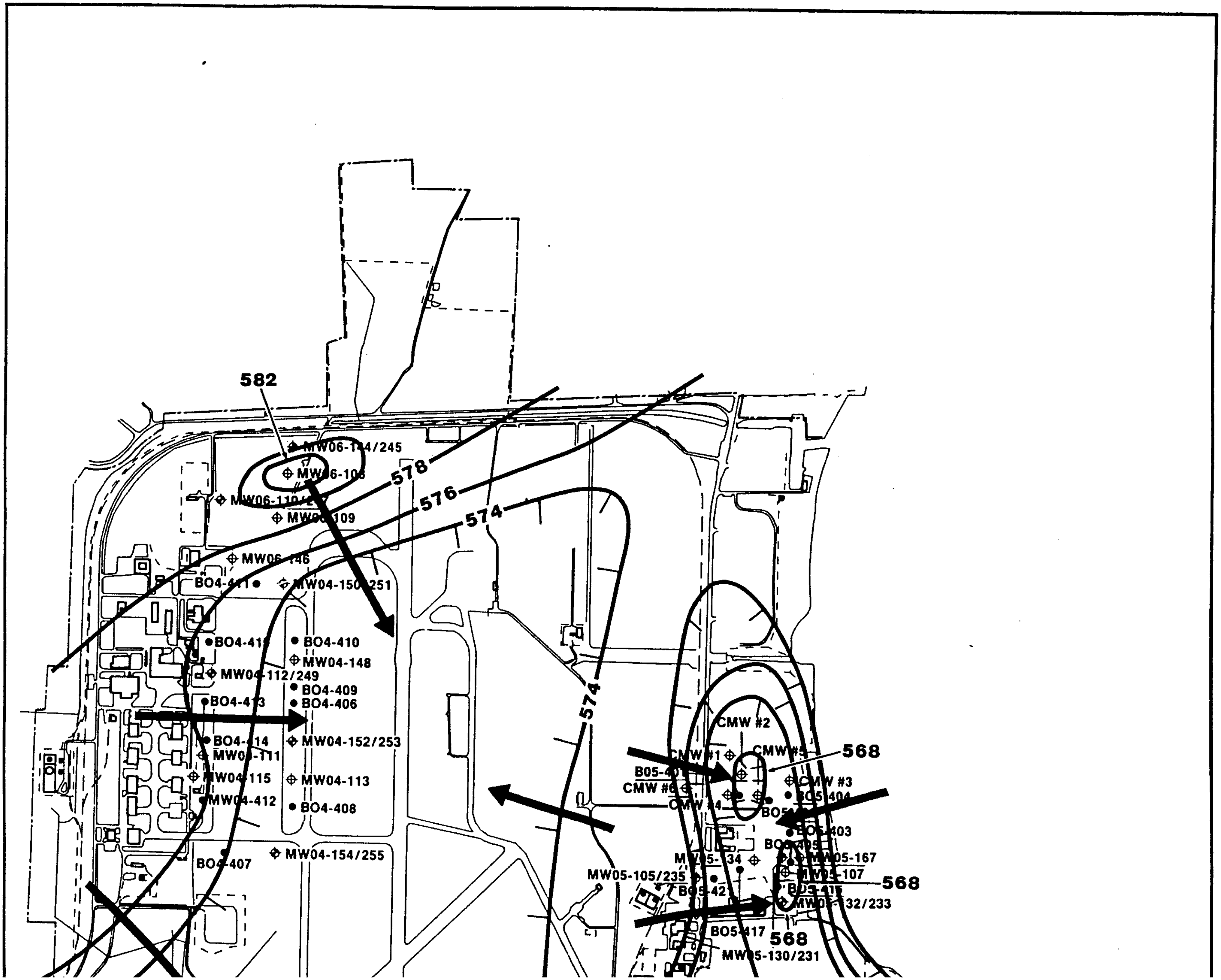


FIGURE 4-12 HYDROGRAPHS FOR SELECTED MONITOR WELLS IN THE EASTERN PORTION OF THE BASE


582
MW06-144/245
MW06-108
MW06-110
MW06-109
578
576
574
MW06-146
BO4-411
MW04-150/251
BO4-410
MW04-148
MW04-112/249
BO4-409
BO4-406
BO4-413
MW04-152/253
BO4-414
MW04-111
MW04-115
MW04-113
MW04-412
BO4-408
BO4-407
MW04-154/255
CMW #2
CMW #1
CMW #5
568
B05-401
CMW #6
CMW #3
B05-404
CMW #4
B05-403
MW05-134
MW05-167
MW05-105/235
MW05-107
B05-42
MW05-132/233
B05-417
MW05-130/231

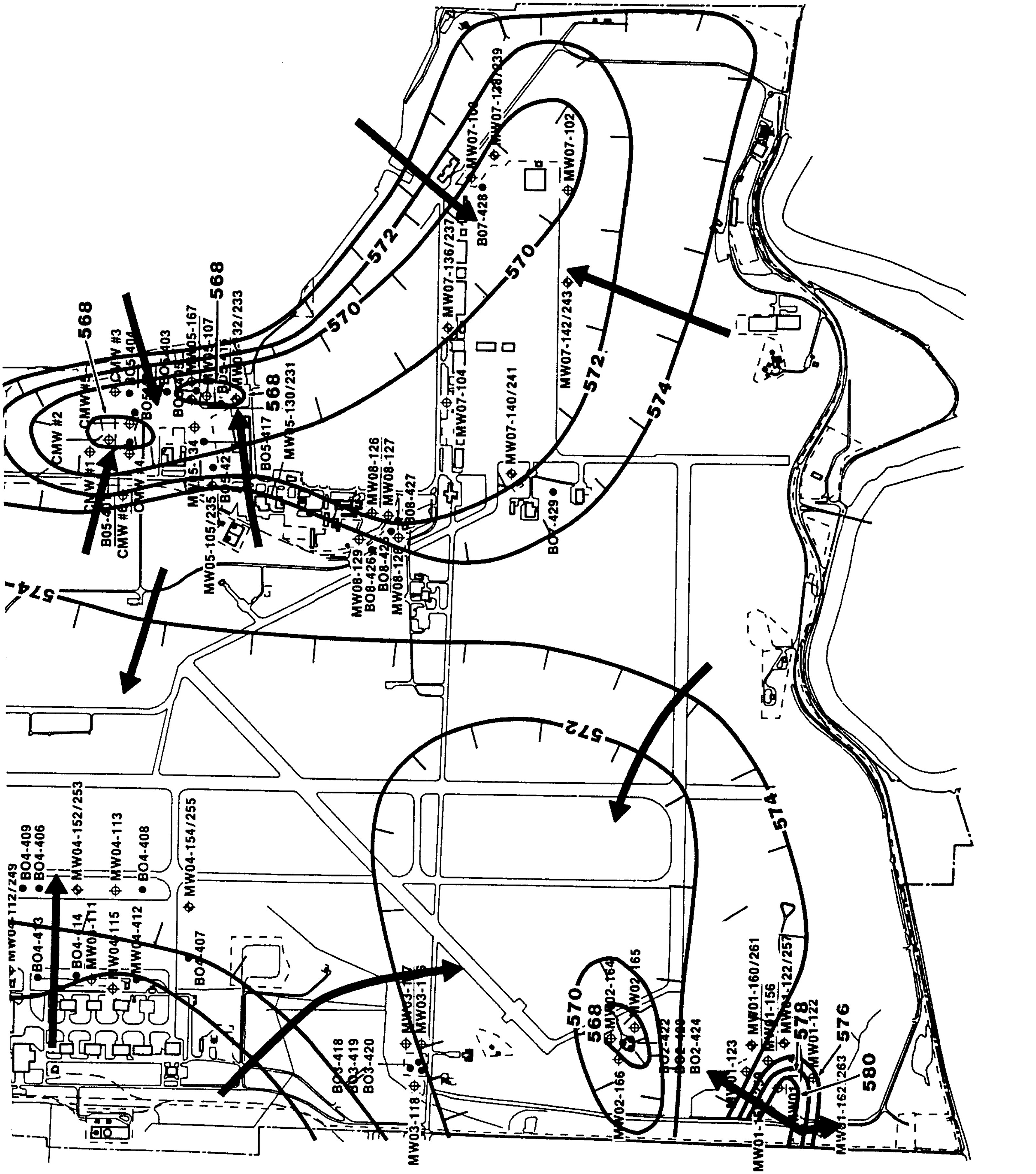


FIGURE 4-13 BASEW
SURFA
MONIT

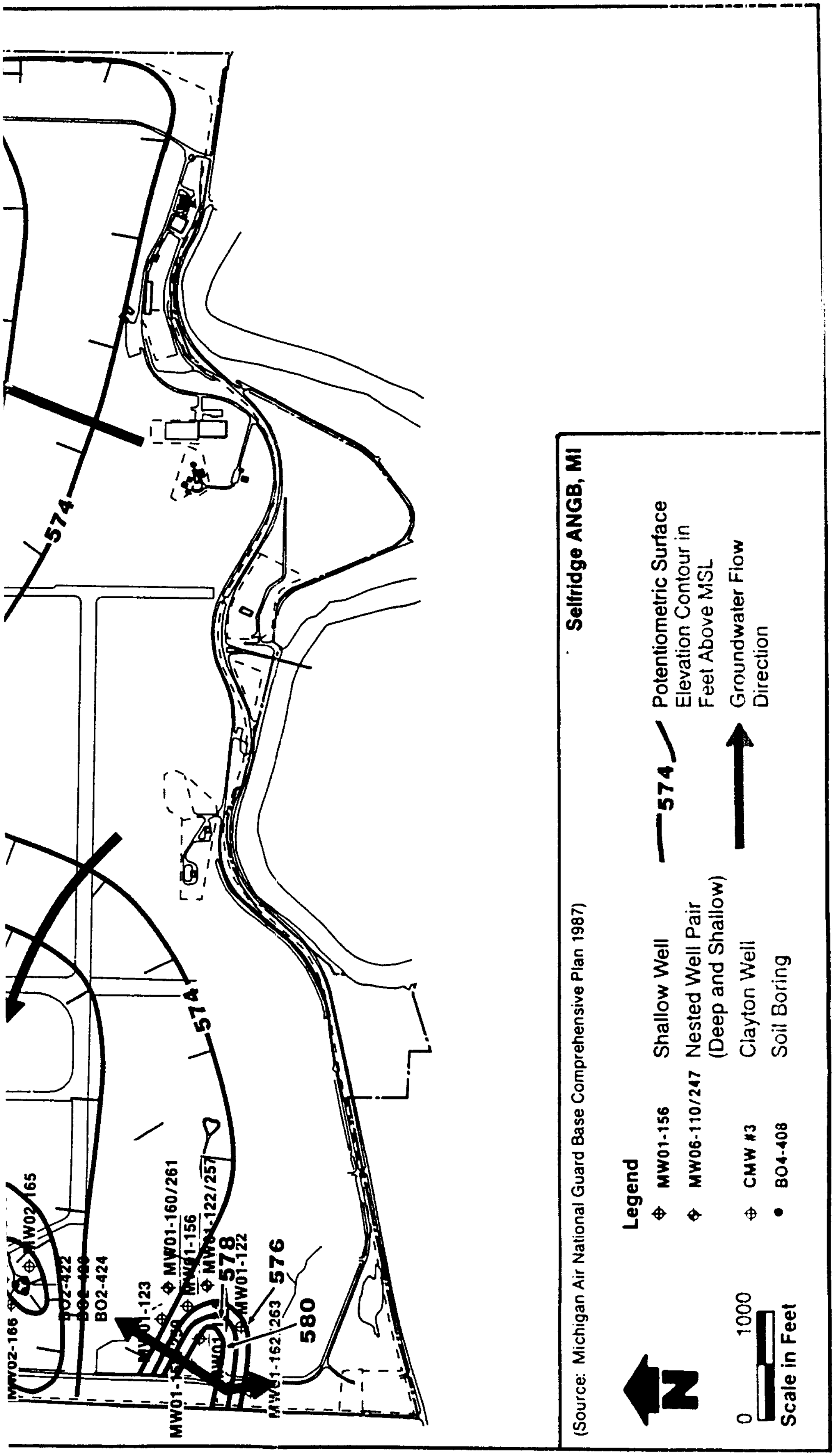
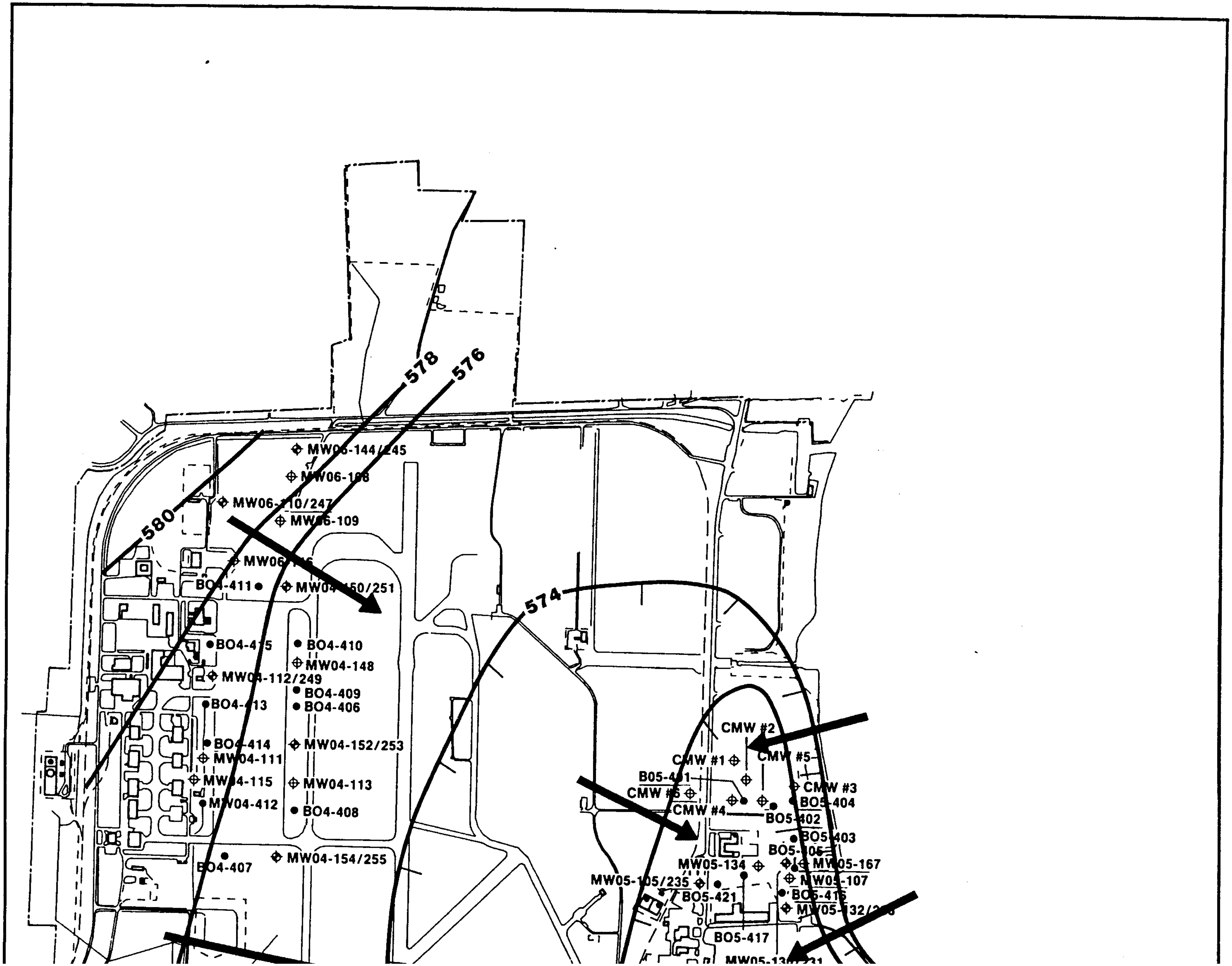


FIGURE 4-13 BASEWIDE POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 1 AUGUST 1988



580
578
576
574
MW06-144/245
MW06-108
MW06-110/247
MW06-109
BO4-411
MW04-150/251
BO4-415
BO4-410
MW04-148
MW04-112/249
BO4-409
BO4-406
BO4-413
BO4-414
MW04-111
MW04-152/253
MW04-115
MW04-113
MW04-412
BO4-408
BO4-407
MW04-154/255
CMW #2
CMW #1
CMW #5
BO5-401
CMW #6
CMW #3
BO5-404
CMW #4
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MW05-134
MW05-167
MW05-105/235
MW05-107
BO5-421
BO5-416
BO5-417

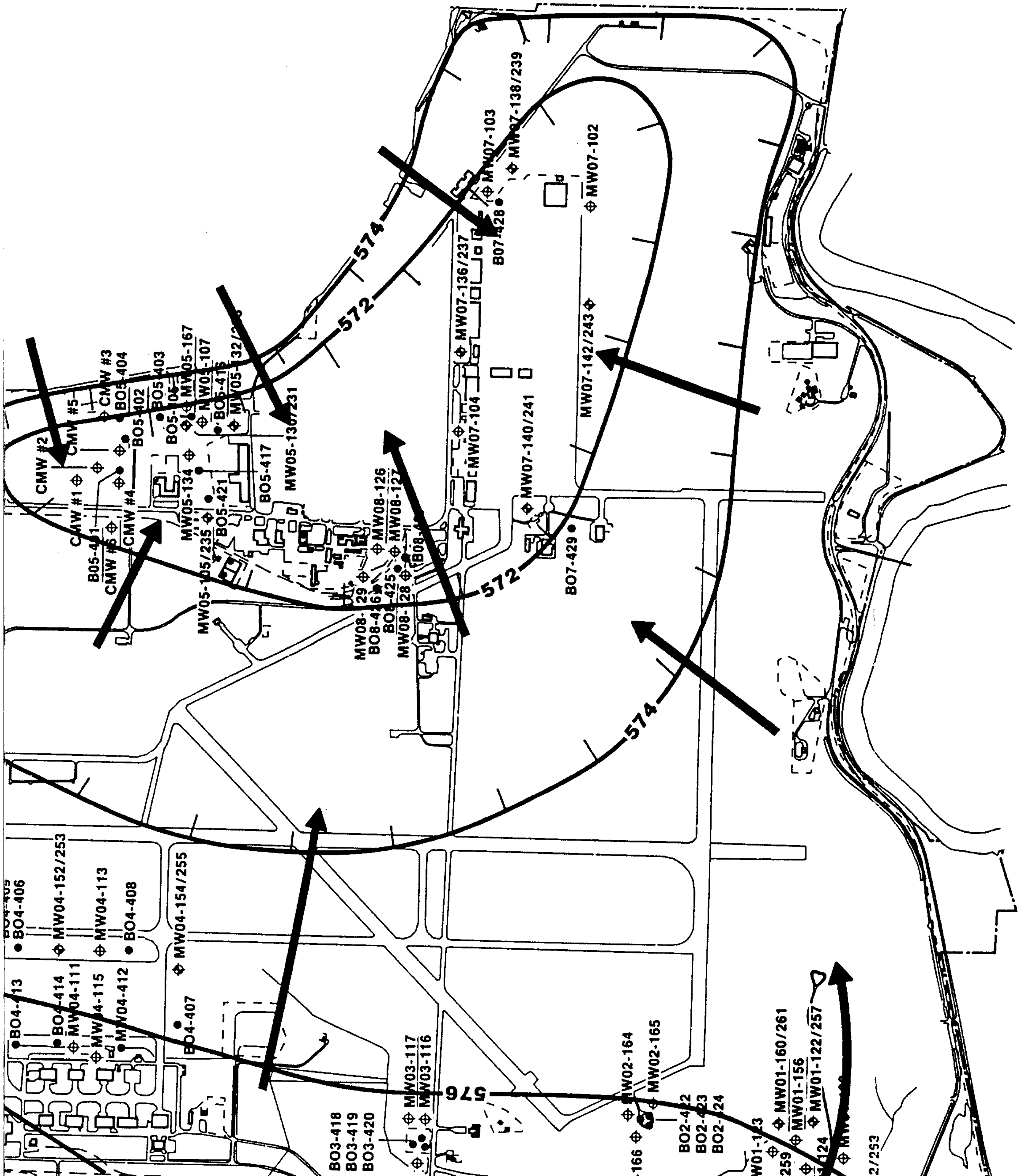

FIGURE 4-14 BASEWIDE
SURFACE
MONITOR

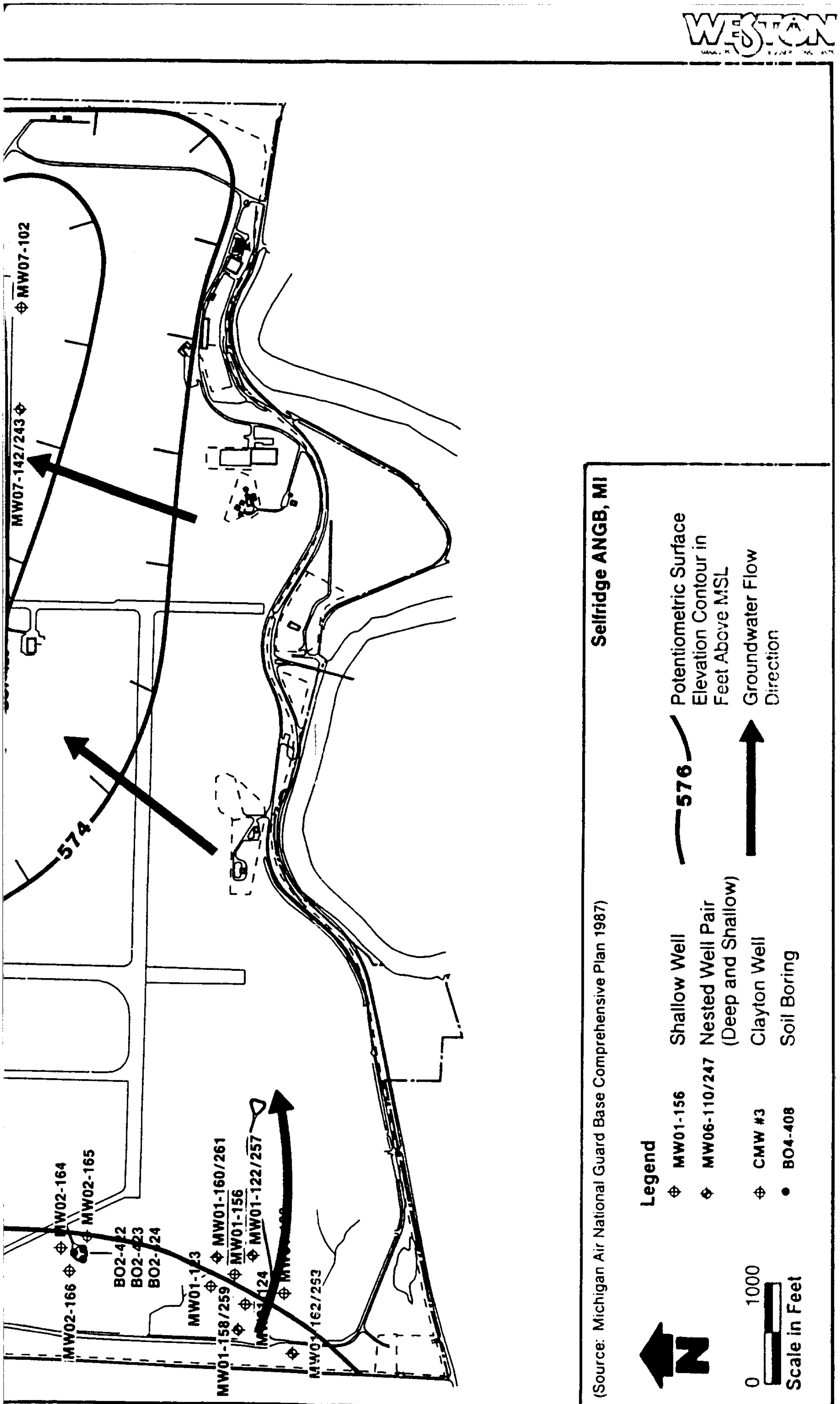

FIGURE 4-14 **BASEWIDE POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 1 AUGUST 1988**

Figures 4-13 and 4-14 can be used to calculate gradients at the site from which typical groundwater flow velocities can be estimated. Horizontal gradients in the shallow zone along the western edge of the base range from 0.0019 ft/ft between FTA-1 and FTA-2 to 0.016 ft/ft at the southern half of SWLF. Gradients at NWLF and WRMP range from 0.0033 ft/ft to 0.0086 ft/ft; and a typical gradient for the western side of the base is 0.0065 ft/ft.

Using the permeability of the lacustrine clays -- in which most of the groundwater represented by the shallow wells occurs -- and an effective porosity of 0.15, flow velocities corresponding to these gradients are calculated to range from 1.3×10^{-8} ft/sec (0.41 ft/yr) to 1.1×10^{-7} ft/sec (3.5 ft/yr) in the southwestern part of the base and from 2.2×10^{-8} ft/sec (0.69 ft/yr) to 5.7×10^{-8} ft/sec (1.8 ft/yr) in the northwestern part of the base. A typical flow velocity for the western side of the base is calculated to be 4.3×10^{-8} ft/sec (1.36 ft/yr).

Horizontal gradients in the shallow zone along the eastern side of the base range from 0.0016 ft/ft southwest of ERMP to 0.16 ft/ft between TCLF and Lake St. Clair. A typical gradient for the eastern side of the base is 0.007 ft/ft. Groundwater flow velocities corresponding to these gradients range from 1.1×10^{-8} ft/sec (0.35 ft/yr) to 1.1×10^{-6} ft/sec (35 ft/yr) and have a typical value of 4.7×10^{-8} ft/sec (1.5 ft/yr).

Thus, typical groundwater flow velocities in the shallow groundwater zone at Selfridge ANGB (8 to 16 ft BLS) are about 1.5 feet per year. The accuracy of these estimates is dependent on the accuracy of the horizontal gradients calculated from Figure 4-13. Examination of this figure shows that there are substantial areas for which there are no water level data -- most notably through the center of the base and along the Clinton River.

Horizontal gradients in the deep zone range from 0.0006 ft/ft between FTA-2 and ERMP and 0.006 ft/ft between TCLF and Lake St. Clair. A typical gradient for the deep zone is 0.0027 ft/ft. Using permeability and effective porosity values for lacustrine clay, groundwater flow velocities corresponding to these gradients are calculated to range from 4.0×10^{-9} ft/sec (0.13 ft/yr) to 4.0×10^{-8} ft/sec (1.3 ft/yr) with a typical value of 1.8×10^{-8} ft/sec (0.57 ft/yr).

Thus, typical groundwater flow in the deep groundwater zone at Selfridge ANGB (25 to 35 ft BLS) is about 0.25 foot per year -- half as fast as the shallow zone. This is consistent with the fact that the stormwater drains are mostly at depths corresponding to the shallow zone, giving that zone a more dynamic character because of the greater potential for minor variations in flow and discharge.

The accuracy of the estimated flow velocities for the deep zone is dependent on the accuracy of the gradients calculated from Figure 4-14. In this respect, Figure 4-14 has the same limitations as Figure 4-13 due to lack of water level data in certain areas of the base. However, the limitations of Figures 4-13 and 4-14 do not affect the conclusion that virtually all of the groundwater on the base discharges to the stormwater drainage system.

Comparison of Figures 4-13 and 4-14 also indicates that vertical gradients between the deep and shallow zones are predominantly upward. This fact further supports the conclusion that groundwater discharge to the stormwater drainage system is occurring in the shallow zone throughout the base. Downward gradients are present at SWLF and NWLF where water levels in the shallow zone are notably higher than adjacent areas. These groundwater mounds may be attributable to the presence of landfills at these sites, but they may also be due to the sandier character of the soils present in these areas. The general presence of upward gradients precludes the downward migration of dissolved constituents at all but those two landfill locations.

4.1.3 Surface Drainage Conditions

Prior to development of Selfridge ANGB and the residential areas outside the base, the base area was characterized by groundwater discharge to local streams and Lake St. Clair. Poorly drained lake-marsh conditions existed landward from the current lake margin. Conversion of the land to agricultural use was accompanied by the construction of a system of drainage ditches to promote discharge of surface and groundwater to Lake St. Clair. Jones drain, located along the northern side of the base, is one of these drainage ditches (see Figure 2-1). Construction and expansion of the base have involved additional filling of low-lying areas, further alteration of surficial drainage ways and ditches, and the installation of a stormwater drainage system.

4.1.3.1 Surficial Drainage System

The Base Comprehensive Plan shows that surficial drainage of water at the base occurs primarily in drainage ditches near or adjacent to Perimeter Road along the northern, western, and southern edges of the base. According to USGS topographic maps for the base area (Mt. Clemens - East and New Haven 7.5-minute quadrangles), two intermittent streams enter the base from the west in the vicinity of WRMP and FTA-2 and join the ditch along Perimeter Road. From the available maps, it is not clear which way the water flows within the ditches or how the water in the ditches leaves the base. Flow along the ditches appears to be southward from WRMP toward SWLF and eastward from NWLF toward

the Main Gate. Direct discharge of these flows to the Clinton River is precluded by the levee underlying North River Road, and direct discharge to Lake St. Clair is precluded by the raised protection levee along the shoreline.

4.1.3.2 Stormwater Drainage System

The stormwater drainage system was constructed primarily to intercept and convey surface water runoff away from base facilities and operational areas. Figure 2-4 shows the primary storm drainage network as it currently exists. A more elaborate secondary system of catch basins, agricultural drain tiles, and stormwater pipes also exists, but it can not be practically displayed at the scale of Figure 2-4.

Stormwater collected in this system is pumped into the Clinton River and Lake St. Clair by five pump/lift stations located along the perimeter of the base. Three of the pump/lift stations discharge stormwater into Lake St. Clair, and the other two discharge stormwater into the Clinton River. All stormwater discharges from the base are untreated.

In addition to intercepting and conveying stormwater off the base, the stormwater drainage system is apparently serving as the discharge point for groundwater throughout most of the base. Thus, this system is a potential pathway of contaminant migration, not only for surface water contamination, but also for groundwater contamination. Furthermore, the much greater rates of flow in the stormwater system mean that contamination in groundwater can be discharged to the environment considerably sooner than if it had to migrate to the lake or river entirely through the subsurface soils at the base.

During collection of surface water samples, oil sheens and films were observed at several locations. These observations highlight the significance of the stormwater system as a contaminant migration pathway, not only for past releases at IRP sites, but also for continuing releases from ongoing operations.

4.1.4 Response of Groundwater and Stormwater Drainage System to Precipitation Events

Water level information collected during this investigation from six continuous water level recorders can be compared with precipitation data for the base to characterize the precipitation/runoff and precipitation/groundwater recharge relationships at Selfridge ANGB.

The primary means of groundwater recharge at the base are by direct percolation of precipitation and by groundwater flow toward the area from land immediately surrounding the base. Recharge of groundwater also occurs from the Clinton River and Lake St. Clair, as shown in Figures 4-13 and 4-14.

The recorded amount of precipitation received at Selfridge ANGB between 17 February and 27 May 1988 is shown in Figure 4-9. This information was collected on base by Detachment 12, 15th Weather Squadron. The period from 17 February to the end of February 1988 is a record of snow accumulation in terms of its water content. During March 1988 a mixture of snow and above-freezing precipitation was received. The period from April to the end of May 1988 records the amount of rain that fell on the base.

The continuous water level recorder data are shown in Figures 4-15 through 4-17. Each plot from a monitor well was paired with one from a stormwater inlet. Locations of these continuous water level recorder pairs are shown in Figure 4-18. Peaks on the stormwater inlet recorder graphs correspond to a rise in water level due to stormwater runoff collecting in the storm drainage network. These runoff peaks can be matched to the precipitation graph, Figure 4-9, to compare the on-set and duration of precipitation to the on-set and duration of runoff.

Comparison of data from the precipitation/runoff event on 6 April 1988, in which 0.68 inches of rain fell at an even rate between 1350 and 2400 hours, shows that the on-set of runoff begins within 40 minutes of the on-set of precipitation at all three recorder locations. The lag time between the on-set of precipitation and the peak runoff flow in the stormwater inlets ranged from 3 hours 20 minutes at WRMP to 7 hours 10 minutes at SWLF/FTA-2. ERMP had an on-set to peak lag time of 5 hours 50 minutes. Evaluation of factors affecting on-set to peak lag times suggests that the principal reason for the observed differences at Selfridge ANGB is the size/area of the upstream drainage network. WRMP has the smallest upstream area, and SWLF/FTA-2 has the largest.

The time between the cessation of precipitation and the return to base flow conditions (i.e., cessation of runoff) ranged from 2 days 10 hours at WRMP to 3 days 17 hours at ERMP. The cessation to base flow lag at SWLF/FTA-2 was 2 days 18 hours. The size of the upstream drainage system appears to be a factor explaining the observations, but additional factors are also needed. One possibility is an uneven distribution of storage within the stormwater system or on the surface feeding into the system. A second possibility is that the proximity of the recorder station at SWLF/FTA-2 to the pump lift station -- and its resultant cyclic effect on water levels during pumping cycles -- has caused a misidentification of the return to base flow conditions.

Water level fluctuations on the monitor well recorder graphs can be attributed to seasonal changes in recharge; to percolation of water into the ground from specific precipitation events; and to recovery of the monitor well following development, baildown testing, or groundwater sampling. Due to the low permeability of the soils adjacent to the monitor well

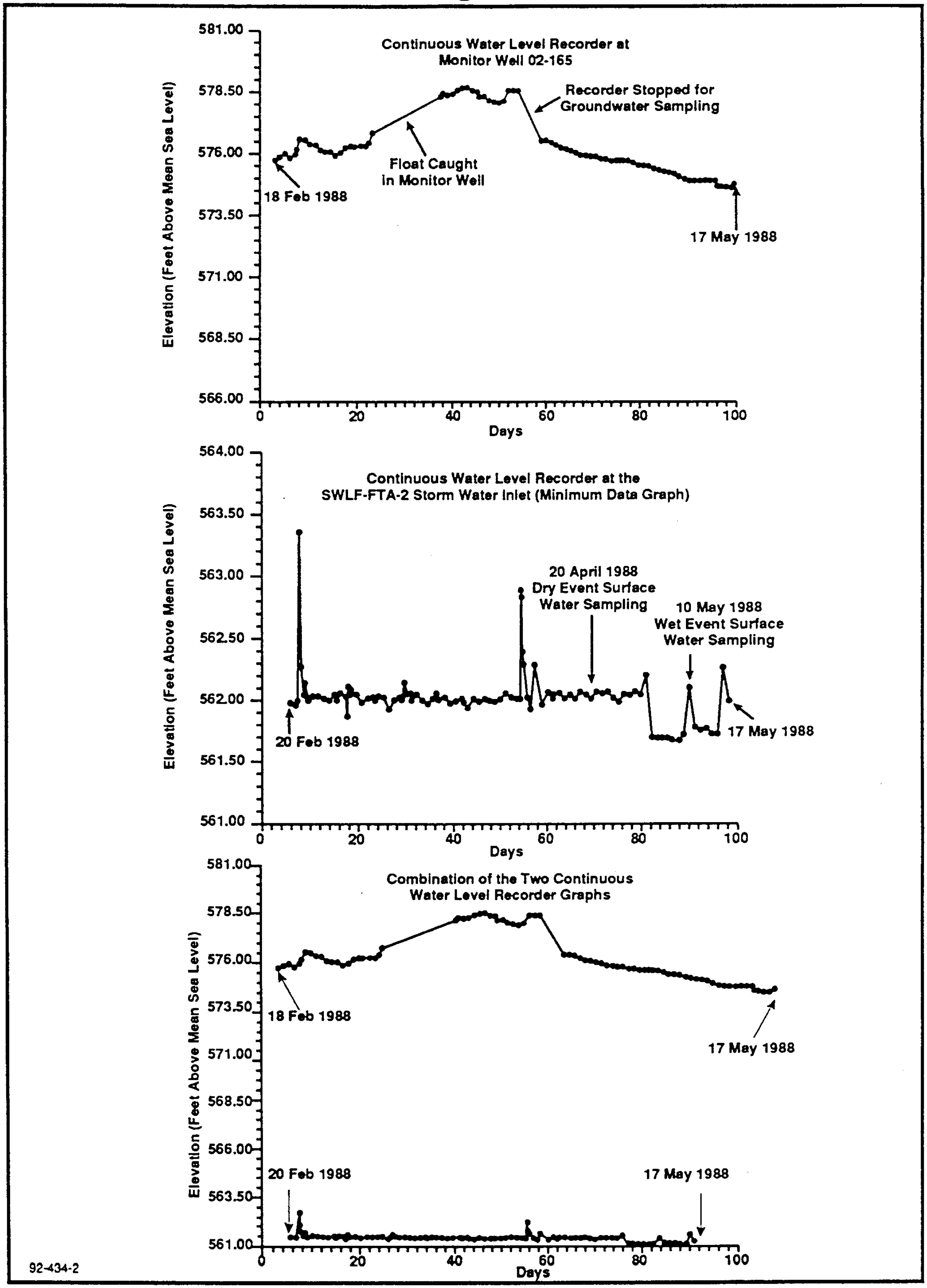

FIGURE 4-15 GRAPHICAL PLOTS OF CONTINUOUS WATER LEVEL RECORDER DATA AT THE SWLF/FTA-2 AREA

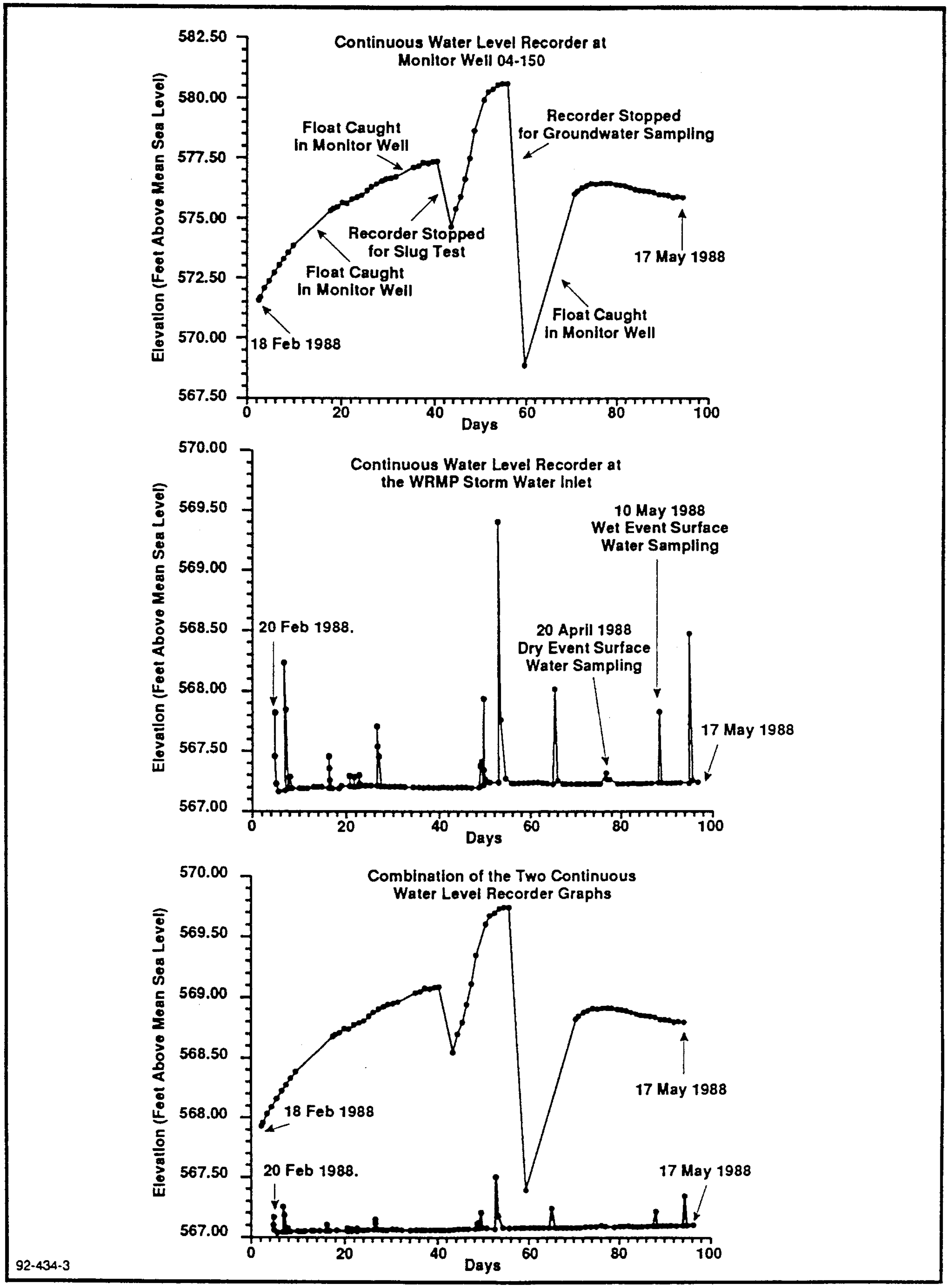

FIGURE 4-16 GRAPHICAL PLOTS OF CONTINUOUS WATER LEVEL RECORDER DATA AT THE WRMP AREA

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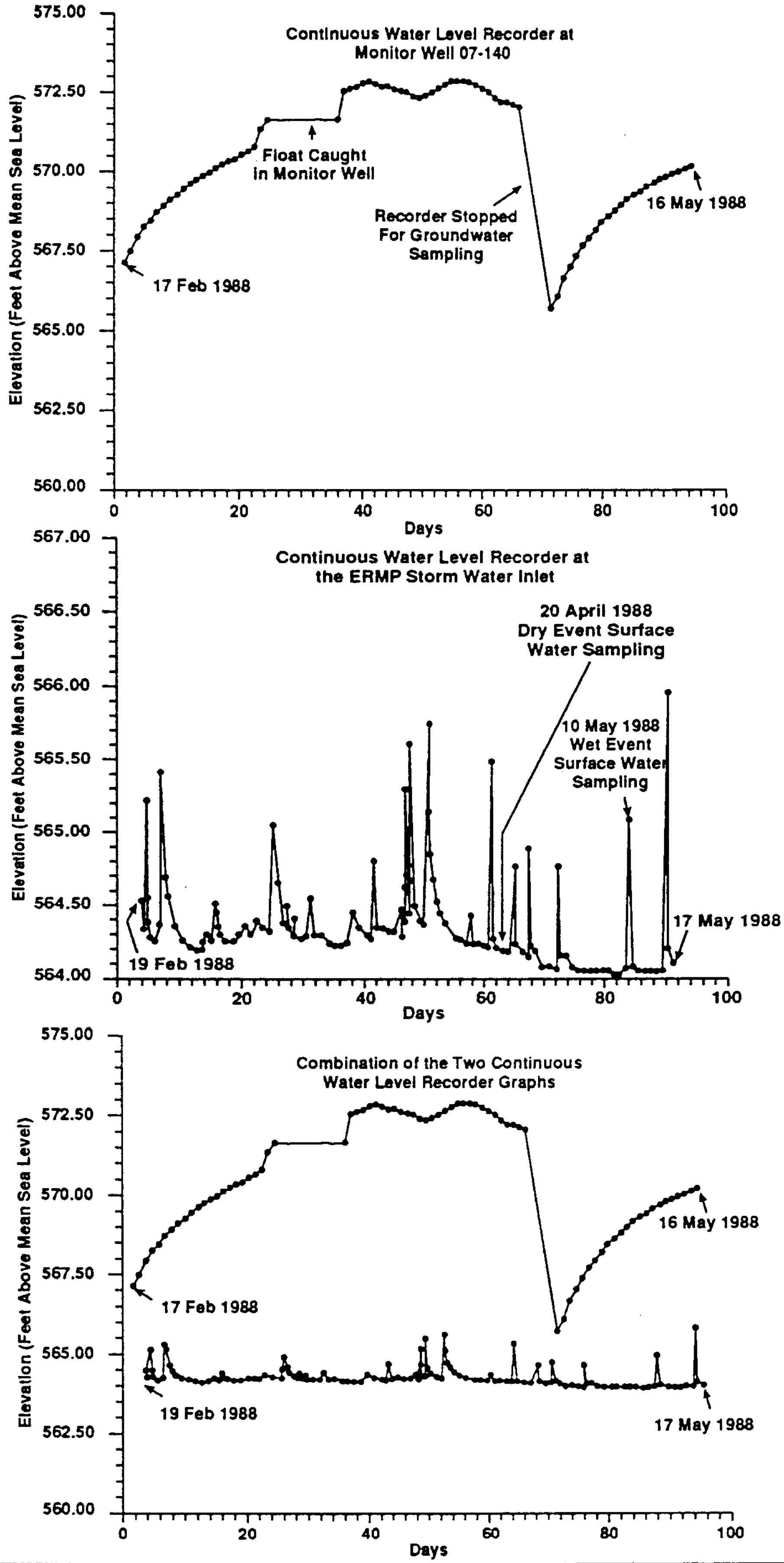

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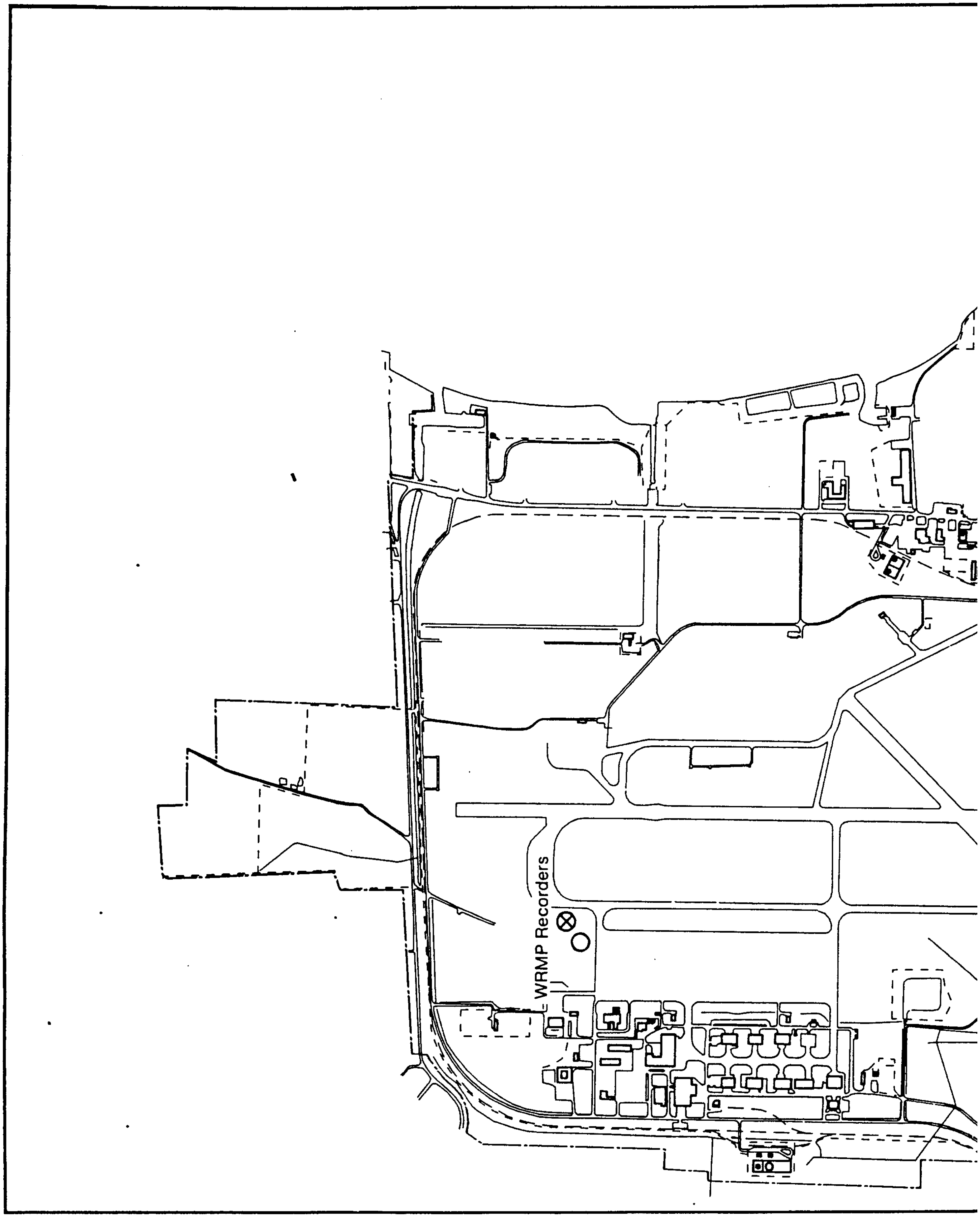
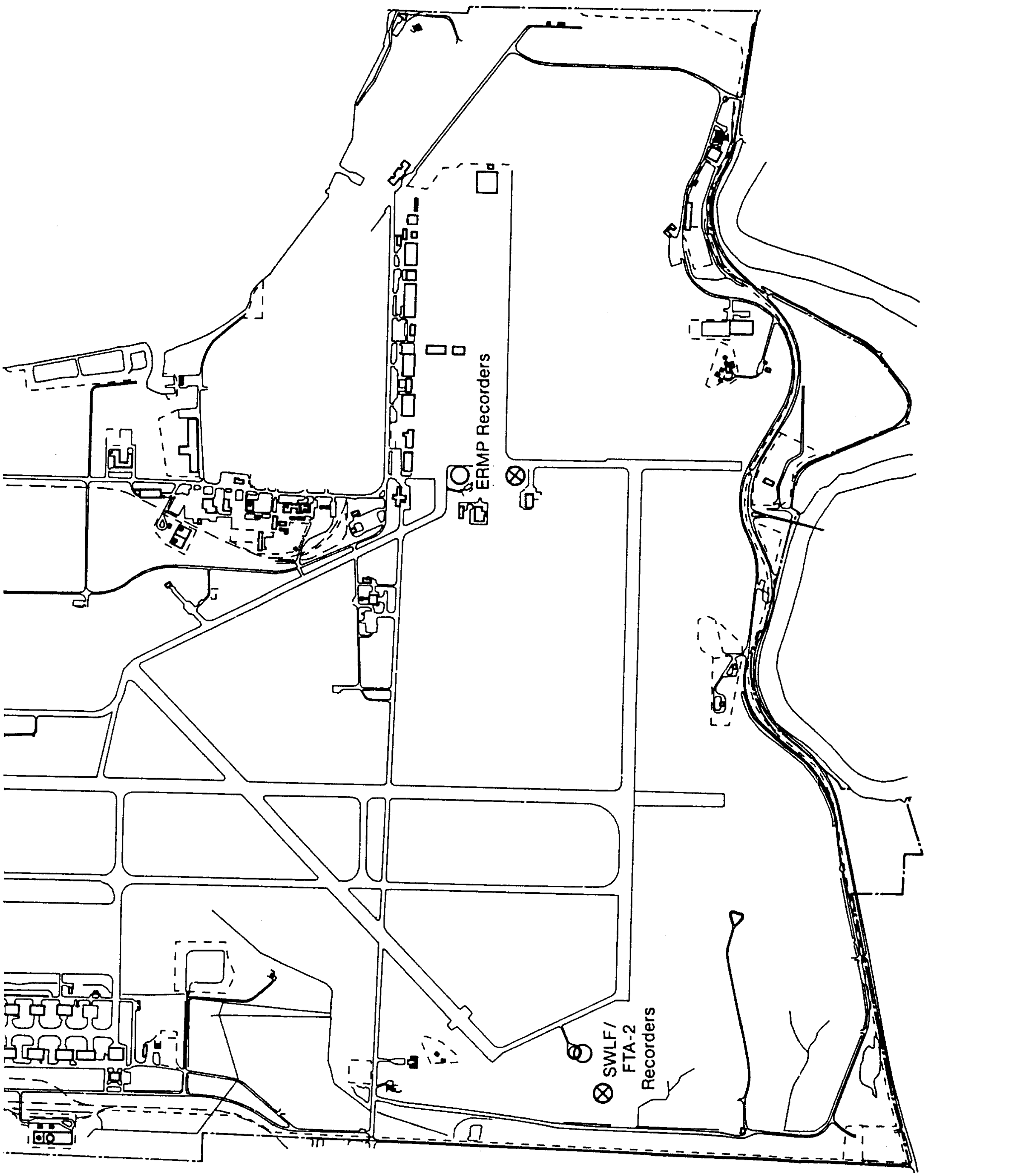
FIGURE 4-17 GRAPHICAL PLOTS OF CONTINUOUS WATER LEVEL RECORDER DATA AT THE ERMP AREA


WRMP Recorders



Selfridge ANGB, MI

(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

**FIGURE 4-18 LOCATION
WATER LE
STATIONS,**

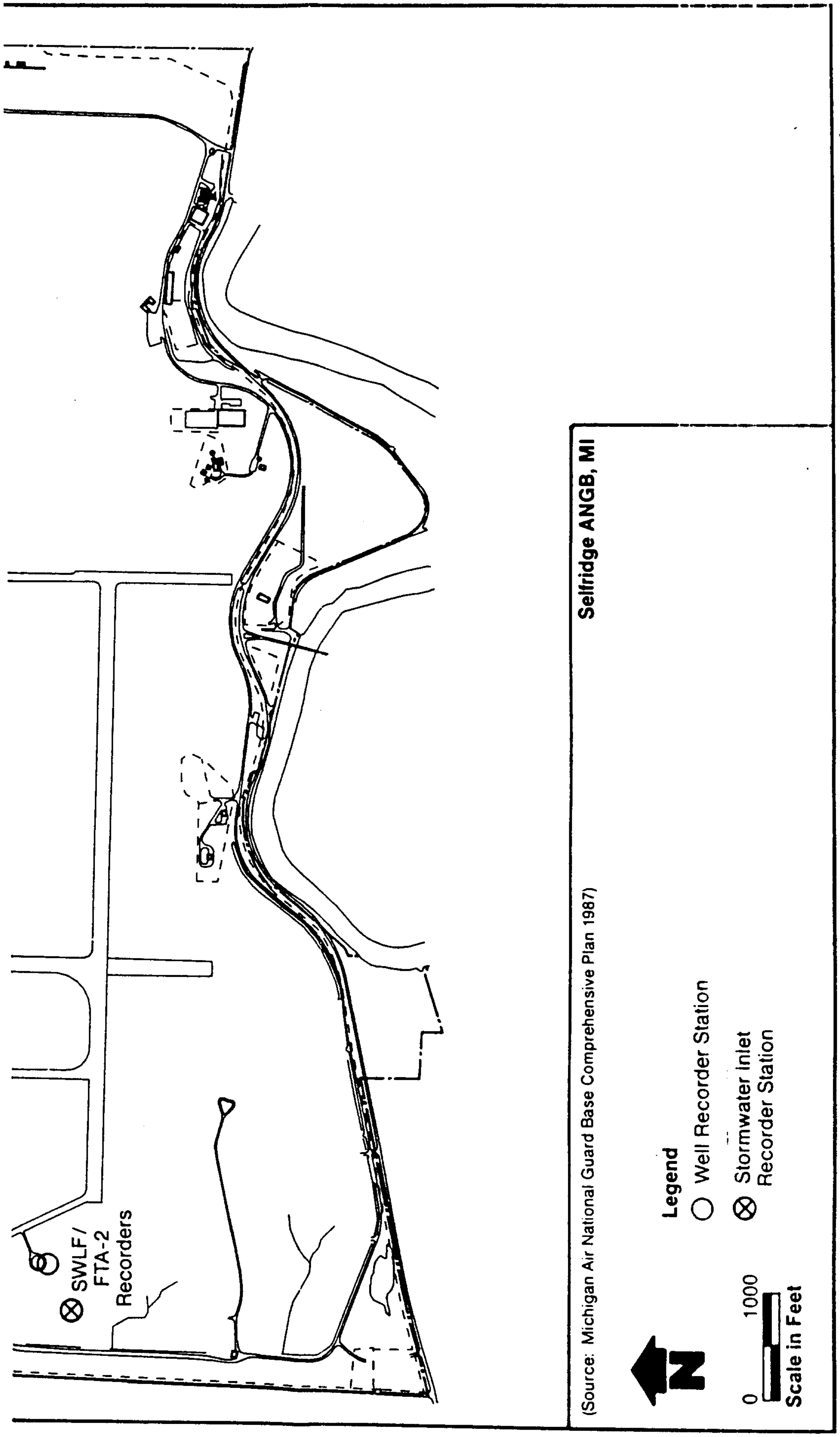


FIGURE 4-18 LOCATIONS OF CONTINUOUS WATER LEVEL RECORDER STATIONS, SELFRIDGE ANGB

screens, the major portion of water level changes recorded in the monitor wells represents recovery of artificially lowered water levels toward equilibrium with ambient groundwater conditions. Attempts to use the continuous water level recorder graphs to compare precipitation and recharge to the water table were unsuccessful because of the repeated interruptions of equilibrium.

4.1.5 Potential Receptors

Selfridge ANGB is located in Harrison Township, Macomb County, on the western shore of Lake St. Clair, approximately 0.5 mile east of the City of Mt. Clemens and directly north of the point where the Clinton River and its associated watershed discharges into Lake St. Clair. The population for Harrison Township was 23,464 according to the 1980 census and was estimated to be 24,400 in 1985. The populations of Mt. Clemens for these two dates were 18,991 and 18,600 (estimated), respectively. More recent population data were not available at the time of this report.

Information provided by the Director of Housing for the base indicates that there is a permanent service population of approximately 1,000 personnel, including family members, living within the boundaries of Selfridge ANGB. A transient service population exists on base, but no information is available on the number of personnel involved. This group consists of service personnel who pass through the base enroute to another location or who are on temporary assignment. They may be at the base for as short as a few hours or as long as several days.

Civilian employees of the base, who are generally present 8 hours per day, 5 days per week, spend about one-fifth of their time at the base. The Selfridge Civilian Personnel Office reported that approximately 2,283 civilian employees worked at the base during 1987. Jobs held by these employees vary from office work to base maintenance.

Maintenance operation jobs are the most likely to result in an employee coming into contact with any contaminants at the IRP sites. Examples of these jobs include but are not limited to roads and ground maintenance, plumbing operations, electrical operations, communications operations, and heating/power operations. Performance of these jobs can involve surficial and intrusive activities such as construction, repair or replacement of underground utilities, or expansion of the base facilities.

Using information provided by base engineering personnel, it is estimated that a limited number of persons are in the vicinity of the IRP sites on a day-to-day basis. Estimates of the number of persons within 1,000 feet of each site on a day-to-day basis are as follows:

Site	Number of Persons Within 1,000 Feet
SWLF	26 - 100 (education center)
FTA-2	1 - 25 (engine testing)
FTA-1	26 - 100 (guardhouse, gate traffic)
WRMP	> 100 (hangars, administrative)
TCLF	> 100 (school)
NWLF	> 100 (hangars, Coast Guard Officer's Club)
ERMP	> 100 (hangars)
BCSP	> 100 (engineering, maintenance)

Visitors to the base also constitute a group that can be exposed to contaminants at the IRP sites. Access to the sites is generally limited or restricted by the nature of a visitor's involvement with base activity. The majority of the IRP sites would not be readily accessed because of their remote locations or proximity to controlled areas of the base.

In one instance, however, visitor access to the base and the IRP sites may be of concern. This situation occurs when the base holds a yearly open house and air show. During this 1-week period in the summer, 150,000 to 200,000 people are estimated to visit the base each day. Military displays located at the ERMP and WRMP provide the opportunity for access to IRP sites. Other areas proximal to the IRP sites or the IRP sites themselves may serve as parking or viewing areas during the air show activities.

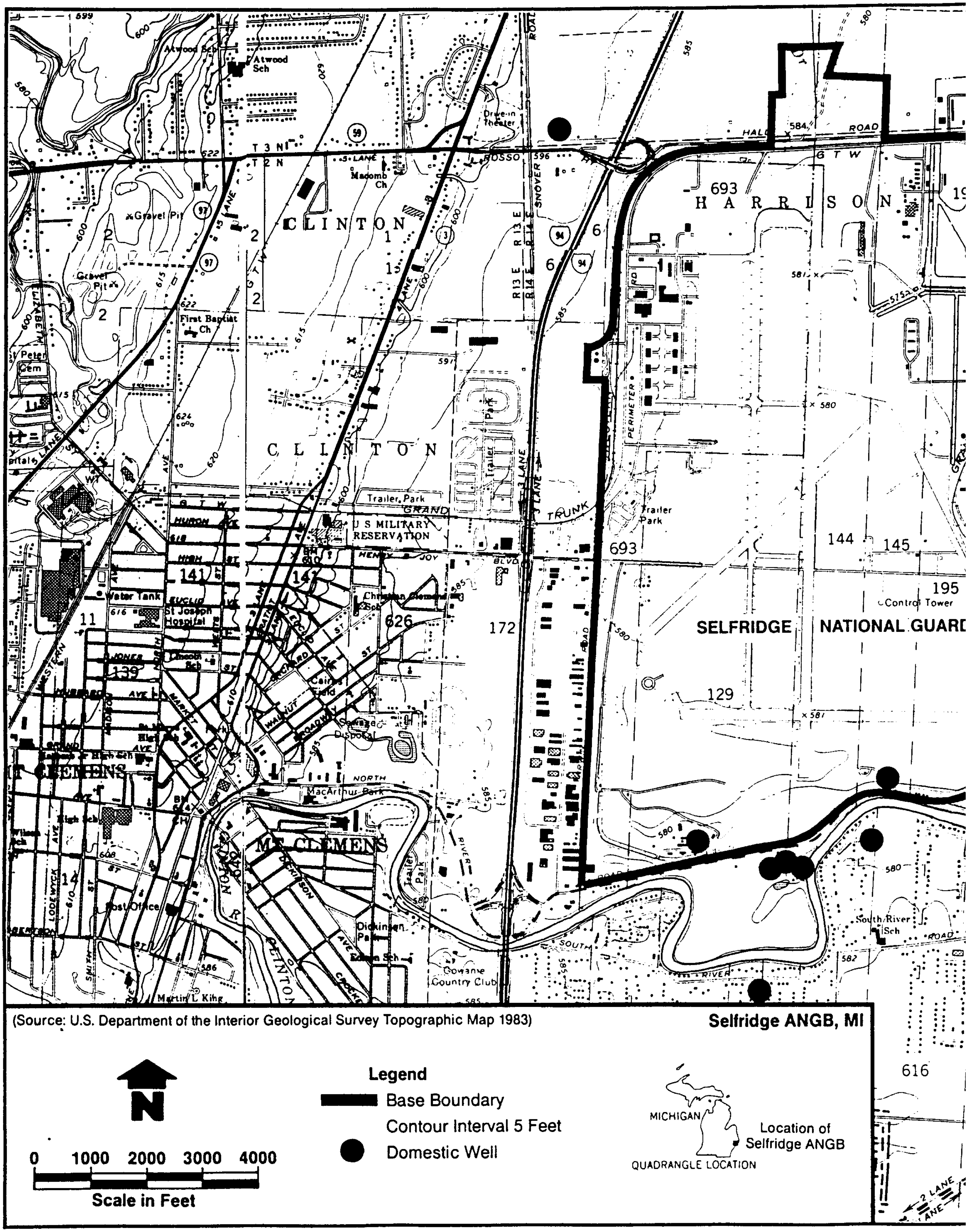
Although there are some wells intended or originally used for drinking water supplies within 1 mile of the base, there are multiple lines of evidence that lead to the conclusion that there are no potential receptors of contaminated groundwater, per se. Table 4-1 summarizes the available data for these wells, two of which are on the base, and Figure 4-19 shows their locations. The lines of evidence indicating that these wells are not potential receptors of contaminants from the IRP sites are the general presence of upward gradients at the base, the fact that groundwater at the base is captured by and discharges to the stormwater system, and the fact that all areas where these wells occur are served by public water supplied by the City of Mt. Clemens.

The first two lines of evidence indicate that groundwater contamination from the IRP sites is likely to remain at depths of 8 to 16 feet and that it will remain on the base until it discharges to the stormwater system. The third line of evidence suggests that even if contaminated groundwater could get down to depths of 25 to 100 feet and off the base to one of these wells, the groundwater pumped by the well would probably not be used for domestic purposes.

Table 4-1

Possible Water Supply Wells Within 1 Mile of Base, IRP Stage 2, Selfridge ANGB, MI

General Location	Depth(ft)	Geology
Near Bldg. 1695	52	No log available
Near Bldg. 1537	59	53 ft of clay over 6 ft of gravel Well screened at 53 to 59 feet
Northwest of base	28	18 ft of clay over 10 ft of sand Well screened at 25 to 28 ft
South of base	50	12 ft of clay over 10 ft of sand and gravel Well screened at 45 to 50 ft
South of base	60	58 ft of clay over 2 ft of sand Well screened at 58 to 60 ft
South of base	75	67 ft of clay over 8 ft of sand and gravel Well screened at 72 to 75 ft
South of base	102	100 ft of clay over 2 ft of sand Well screened at 100 to 102 ft
South of base	130	98 ft of clay over 32 ft of slate Open hole from 98 to 130 ft
South of base	144	101 ft of clay over 43 ft of slate Open hole from 101 to 144 ft



(Source: U.S. Department of the Interior Geological Survey Topographic Map 1983)

Selfridge ANGB, MI

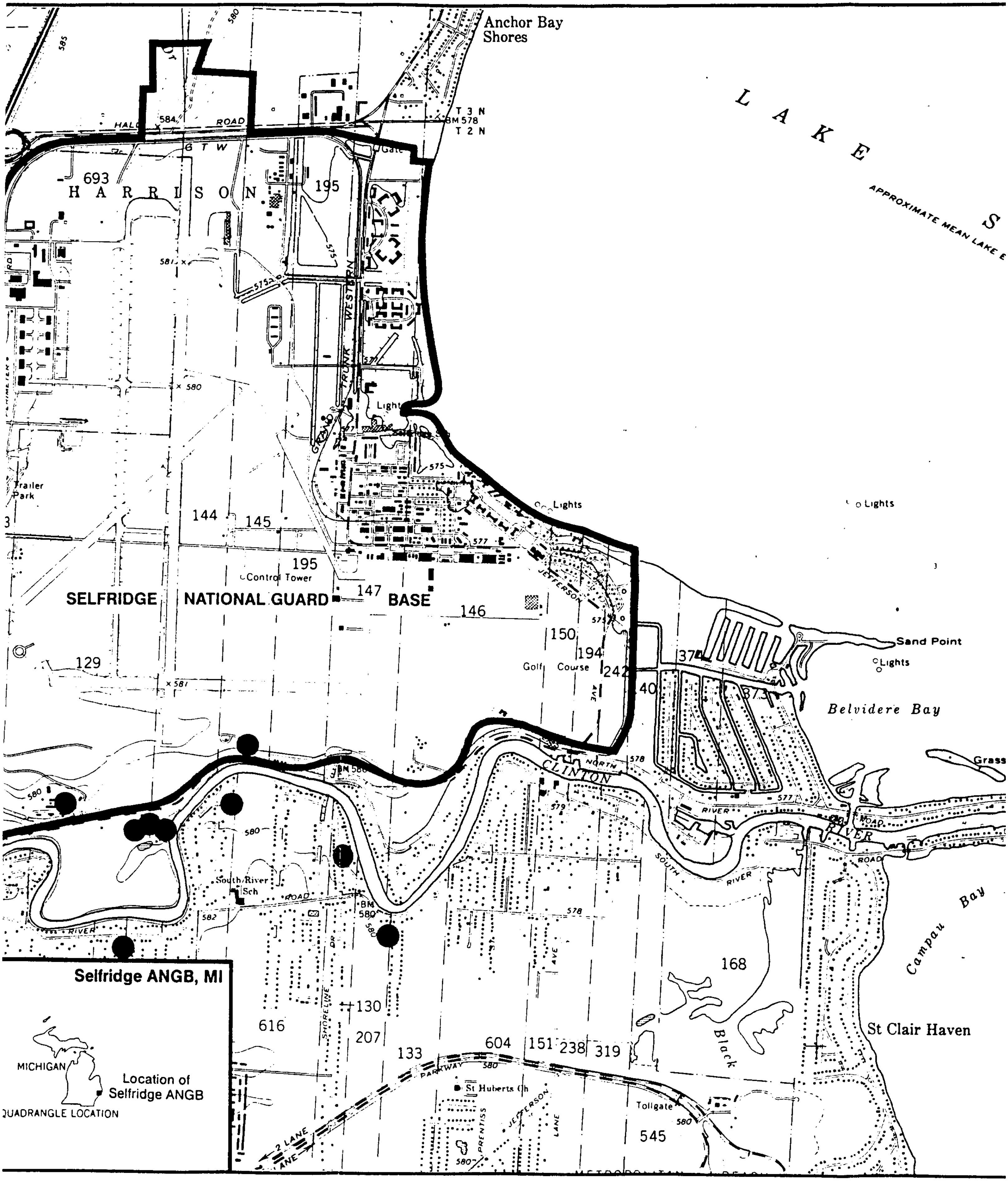

Anchor Bay Shores
LAKE
APPROXIMATE MEAN LAKE
HARRISON
SELFRIDGE NATIONAL GUARD BASE
Control Tower
Golf Course
Trailer Park
Lights
Sand Point
Belvidere Bay
CLINTON
RIVER
South River Sch
St Huberts Ch
Tollgate
Campau Bay
St Clair Haven
Black
Selfridge ANGB, MI
MICHIGAN
Location of Selfridge ANGB
QUADRANGLE LOCATION

FIGURE 4-19

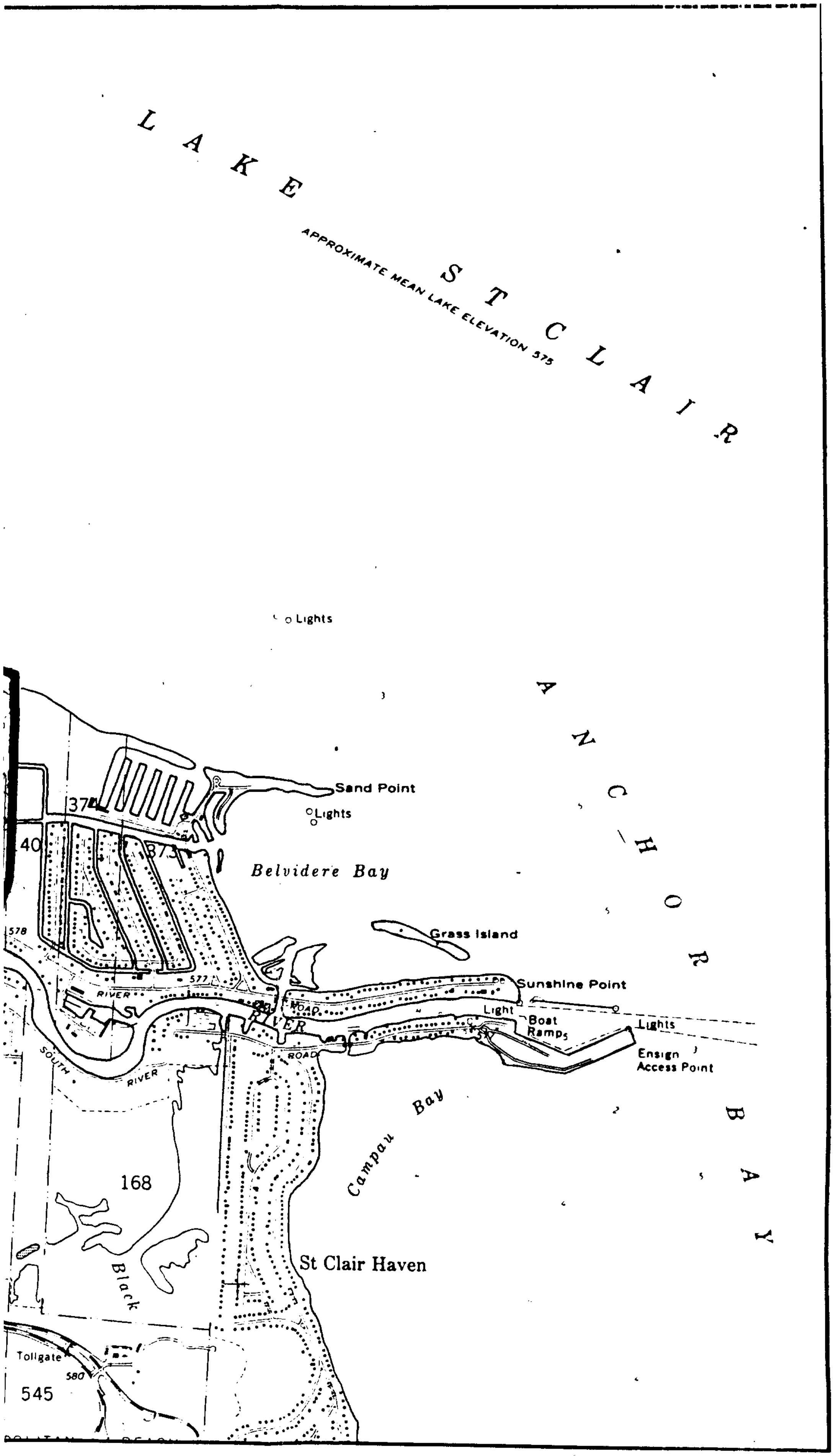


FIGURE 4-19 LOCATIONS OF DOMESTIC WELLS WITHIN A 1-MILE RADIUS OF SELFRIDGE ANGB

Conversations with staff at the Mt. Clemens Filtration and Pumping Plant indicate that, to the best of their knowledge, there are no users of groundwater for domestic use within the service area of the public water system. In addition, during the IRP Stage 2 study, base personnel responsible for pump maintenance reported that no wells were being used to supply any water needs on the base.

Some surface water at the base is present in ditches, and receptors could be exposed to contaminants present in this water. The ditches occur primarily along Perimeter Road and in the western part of the base. The absence of other base facilities in the vicinity of the ditches tends to suggest that direct contact by humans is relatively unlikely. The possibility of exposure to terrestrial or aquatic organisms exists, but its significance can not be assessed with the current data.

Stormwater runoff from the base and groundwater collected in the stormwater drainage system are pumped into the Clinton River and Lake St. Clair at five pump/lift stations. Populations that may contact contaminated surface water discharged from the base include human and other biological receptors that may contact Clinton River and Lake St. Clair surface waters south and east of Selfridge ANGB. Mt. Clemens obtains its drinking water from an intake about 1 mile offshore in Lake St. Clair south of the Clinton River. Although this location might be considered downstream from the base, the travel distance is greater than 6 miles, and significant dilution of any surface water contamination from the base should occur prior to contact with this intake.

Human contact with affected surface waters in the river and lake may occur through fishing, canoeing, and swimming. Most of the contact would occur off base in the metropolitan beach area, which is located between the mouth of the Clinton River and its spillway canal on Lake St. Clair. Additional contact may occur by use of the boat basin located southeast of TCLF.

Biota that may come into contact with IRP site contaminants include both terrestrial and aquatic organisms. A variety of animals are known to live within the confines of the base (see Subsection 2.5). However, no Federally listed endangered or threatened species reside in the area (Michigan DNR, 1988).

Aquatic organisms found in the Clinton River and Lake St. Clair may also be exposed to contaminants. As a receptor of contaminants, the aquatic food chain may concentrate or bioaccumulate certain compounds. Fish harvested by sport fishermen may serve as a pathway for these compounds to reach human receptors.

The lower Clinton River is a designated warmwater fishery stream. Yellow perch and alewife are the predominant species. The river also supports northern pike, yellow perch, pumpkinseed, largemouth and smallmouth bass, rock bass, white bass, black crappie, walleye, and muskellunge (Michigan DNR, 1988).

The Clinton River also discharges into Lake St. Clair, which connects Lake Huron with Lake Erie via the St. Clair and Detroit Rivers. Lake St. Clair supports a variety of sports fish including walleye, muskellunge, northern pike, yellow perch, black crappie, rock bass, largemouth and smallmouth bass, channel catfish, and bluegill. Commercial fishing is not allowed on Lake St. Clair. The lake also supports a large number of wintering and migratory waterfowl (Michigan DNR, 1988).

4.2 INTERPRETATION OF ENVIRONMENTAL CHEMICAL DATA

The IRP Stage 2 study at Selfridge included laboratory analysis of soil, surface water, and groundwater for a wide range of organic and inorganic parameters. The results indicate that all three of these media have been affected to some degree by past waste disposal practices at the eight IRP sites. Although the nature of the effect at each site is somewhat unique, many of the compounds occur at more than one site. Similarities among sites occur not only from common disposal settings (e.g., landfill, fire training area, ramp), but also from common waste streams. The complete analytical data reports are presented in the 14 October 1988 Informal Technical Information Report.

This subsection presents information used to interpret and understand the environmental chemical data obtained during IRP Stage 2 at Selfridge. It includes summaries of the composition of the materials/wastes/sources causing or found to have caused contamination at the IRP sites, the migration of these materials in the subsurface, and processes that remove them from the subsurface. This subsection also presents the procedures for identifying which of the many chemicals found at each of the IRP sites are of concern for the purposes of qualitative risk assessment and summarizes the characteristics and environmental behavior of these "contaminants of concern." Finally, available information regarding background concentrations of the chemicals found at Selfridge ANGB is presented.

4.2.1 Composition of Selfridge ANGB Wastes/Sources

Past and present daily operations at Selfridge ANGB involved the storage, use, and disposal of a number of potentially hazardous materials. Consistent with the general results of analytical testing performed during the IRP Stage 2 study, these hazardous materials can be divided into three groups: hydrocarbon fuels and oils; solvents, pesticides, and acids; and landfill leachate.

4.2.1.1 Composition of Hydrocarbon Fuels and Oils

Several types of petroleum-based fuels are used during normal operations at Selfridge ANGB. Aviation fuels are used for flight operations, gasoline and diesel fuels for ground transportation, fuel oils are used to heat structures, and lubricating oils for vehicle maintenance. All these fuels are refined products derived from crude oil, with selected additives included to improve performance (e.g., anti-knock additives).

According to McDuffie (1982), petroleum (or crude oil) is a complex mixture of hundreds of organic compounds, primarily hydrocarbons. Principal constituents are aliphatics (85 to 95 percent) including alkanes and alkenes (olefins), and aromatics (5 to 15 percent) including the monocyclic aromatics (e.g., benzene, toluene, xylenes) and the polycyclic aromatics (e.g., naphthalene). Crude also contains sulfur compounds, amines, and metals (particularly nickel and vanadium). Figure 4-20 is a diagrammatic representation of a typical gas chromatogram of a crude oil showing the boiling ranges of the refined fractions. The principal refined fuel and oil types are described in the following paragraphs.

Gasoline

Gasoline is derived from the most volatile fraction of crude oil, i.e., the fraction having the lowest boiling temperatures. Compositions of gasoline vary greatly between brands and according to source crudes, but generally include about 50 percent alkanes, 40 percent cyclic alkanes, 10 percent monocyclic aromatics (primarily toluene, with lesser amounts of benzene, ethylbenzene, and xylenes), and low percentages (<1 percent) of polycyclic aromatics (naphthalene). Gasoline additives include anti-knock agents (e.g., tetraethyl lead, ethylene dibromide, alkyl ethers), anti-oxidants (e.g., phenols), metal deactivators (e.g., copper), anti-rust agents (e.g., isopropyl alcohol, methanol), anti-precipitation agents (phosphorus compounds), and heavy-oil lubricants. Little information exists concerning types and amounts of trace metals in gasolines due to the proprietary nature of commercial additives. However, information available in internal WESTON files indicates that the following metals have been found at varying concentrations in commercially available petroleum-based fuels (including gasolines): arsenic, barium, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, mercury, nickel, and vanadium. Table 4-2 lists the components of gasoline.

Diesel and No. 2 Fuel Oil

Diesel fuel contains a relatively smaller proportion of volatile compounds and a higher proportion of heavier compounds than gasoline. Diesel usually contains small percentages of toluene and xylenes, but little or no benzene. Diesel and No. 2 Fuel Oil may also contain additives as described for gasoline. Table 4-3 lists the composition of typical light fuel oils, which are similar to diesel fuel.

Kerosene

Kerosene is a slightly lighter mix of the same compounds as diesel and includes some alkanes and aromatics intermediate between diesel and gasoline. Kerosene has a higher flash point temperature, making it safer to handle. Kerosene contains substantially less benzene, toluene, and xylenes compared to gasoline.

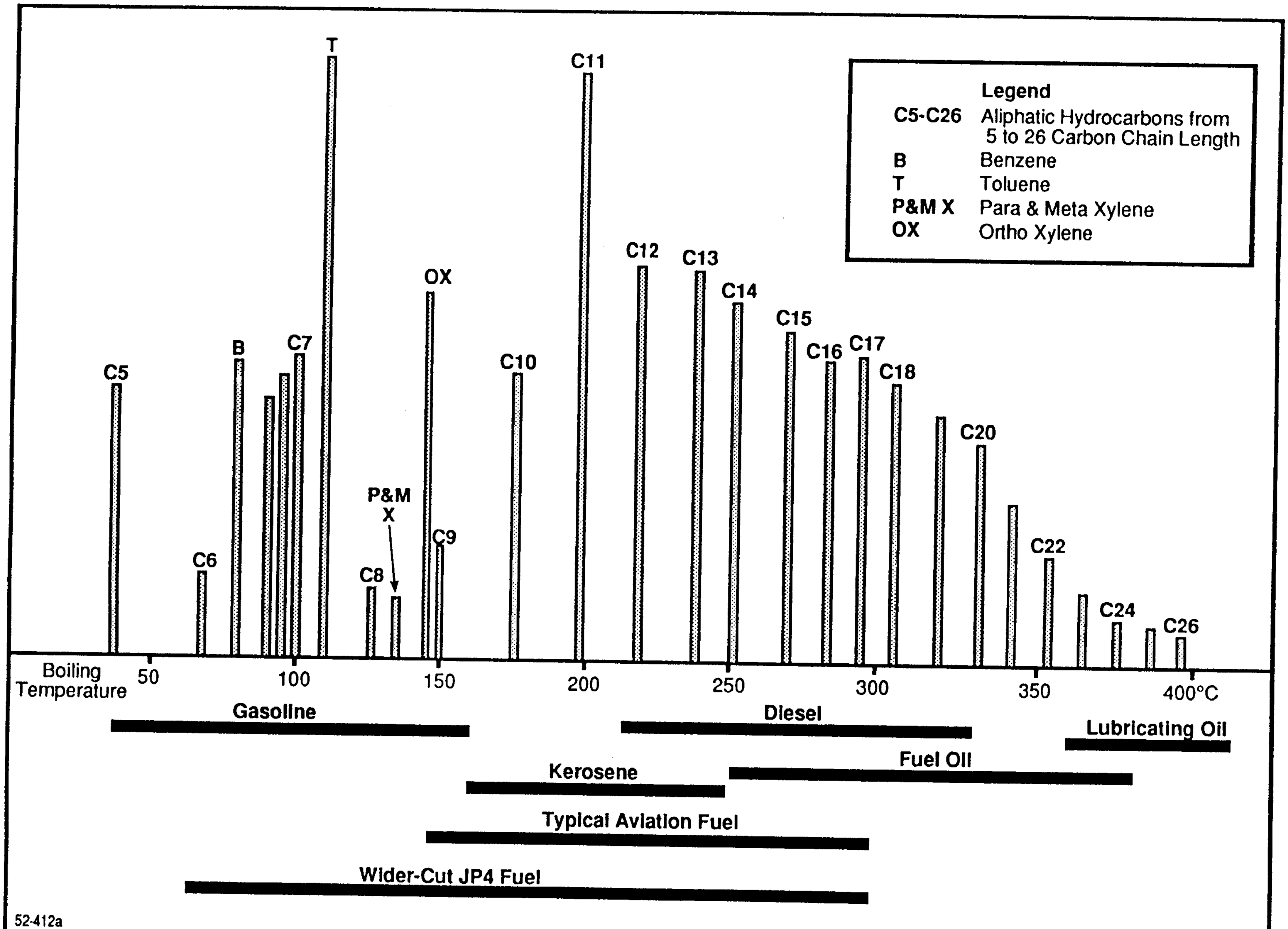


FIGURE 4-20 GAS CHROMATOGRAM OF TYPICAL CRUDE OIL SHOWING COMMON CHEMICAL COMPONENTS AND RANGE OF MAJOR DISTILLATE PRODUCTS (ADAPTED FROM MONITORING REVIEW, WINTER 1987)

WESTON

Table 4-2

Composition of Gasoline, IRP Stage 2, Selfridge ANGB, MI

Hydrocarbon Groups	Percent Composition Typical	Range
Alkenes	52.6	30-60
Monocycloalkanes	34.6	5-55
Dicycloalkanes	5.2	0-2
Alkylbenzenes (BTX, etc.*)	6.3	5-50
Indans and tetralins	0.9	Low
Naphthalenes	0.3	Low

Gasoline Additives	Typical Concentration
Antiknock agents: tetraethyl lead (TEL), ethylene dibromide; alkyl ethers in "no lead" gas	(proprietary)
Anti-oxidants (anti-gum): alky-subst. phenols	50 ppm
Metal (Cu) deactivators	4 ppm
Anti-rust agents and anti-stall agents: methanol and isopropyl alcohol	50 ppm
Anti-pre-ignition agents	200 ppm
Upper-cylinder lubricants-oil	0.2 - 0.5 percent

*B = Benzene, up to 5 percent.
T = Toluene, up to 20 percent.
X = Xylenes, low percent.
etc. = Ethylbenzene, propylbenzene
McDuffie, 1982.

Table 4-3

Composition of Light Fuel Oils,
IRP Stage 2, Selfridge ANGB, MI

Mass Spectrometer Analysis of Two Typical Samples
(weight percent)

Paraffins	43.0	56.6
Monocycloparaffins	3.7	8.2
Dicycloparaffins	5.6	8.9
Tricycloparaffins	1.6	2.2
Alkylbenzenes	13.2	9.6
Indans/Tetralins	7.0	5.4
Indenes	1.8	2.6
Naphthalene	0.4	0.3
Naphthalenes	12.8	3.6
Acenaphthenes	5.4	1.4
Acenaphthylenes	3.7	0.8
Tricyclic aromatics	1.8	0.4
	100.0	100.0
Nonaromatics, wt percent	52.8	69.3
Aromatics, wt percent	47.2	30.7
	100.0	100.0

Polynuclear Aromatics (ppm)

Indene	5.9	0.12
Naphthalene	660	<20
1-Methylnaphthalene	2,740	41
2-Methylnaphthalene	4,340	109
Acenaphthene	39	<10
Acenaphthalene	60	24
Fluorene	320	263
1,4-Dimethylnaphthalene	3,450	583
Phenanthrene	750	301
Fluoranthene	7.8	2.3
Anthracene	3.0	39
Pyrene	17	2.3
Benzo(a)anthrancene	1.3	<0.09
Chrysene	0.79	<0.11

Table 4-3
(continued)

Polynuclear Aromatics (ppm)		
Benzo(b)fluoranthene	<0.20	<0.20
Benzo(k)fluoranthene	<0.04	<0.04
Benzo(a)pyrene	0.60	<0.30
Benzo(g,h,i)perylene	0.52	<0.30
Indeno(1,2,3-c,d)pyrene	<0.30	<0.30
Perylene	<0.90	<0.90
Dibenzo(a,h)anthracene	<0.50	<0.50
Dibenzo(d,e,f,p)chrysene	<0.15	<0.15
9,10-Dimethylanthracene	26	<0.27
2-Methylanthracene	326	55
Benzo(a)fluorene	18	<0.40
7,12-Dimethylbenzo-(a)anthracene	1.8	<0.43
Dibenzo(a,e)pyrene	<0.30	<0.30
Benzo(b)chrysene	<0.30	<0.30
Picene	<1.4	<1.4
Coronene	<0.30	<0.30
Dibenzo(a,h)acridine	<0.13	<0.13
Dibenzo(a,h)pyrene	<0.70	<0.70
3-Methylcholanthrene	<0.08	<0.08
2,3-Benzofluorene	68	<0.25
Benzo(g,h,i)fluoranthene	5.5	<0.04
Naptho(1,2,3,4-d,e,f)chrysene	<0.10	<0.10

Adapted from API Technical Report #1.

Aviation Fuel (Gas Turbine Fuels)

Fuels for aircraft gas turbines evolved from ordinary household kerosene and have become major distillate products serving world-wide airlines, military forces, and general aviation. Most aviation fuel is kerosene of the 150 to 300°C boiling range from crude. It is highly paraffinic, meeting the aircraft's need for a liquid of maximum heat content to be converted into engine thrust. For long-range flights, an international version of jet fuel of lower final boiling point is needed to prevent wax formation at low temperatures. The U.S. Air Force has always used a wider-cut fuel combining naphtha (gasoline) and kerosene fractions in order to maximize availability. Aviation fuel JP-4 is the name of this blend of gasoline and kerosene. The gasoline fraction is close to normal gasoline, but it is a higher octane blend. The aviation fuel JP-6 is primarily kerosene. The greater volatility of wider-cut fuel (JP-4) causes lower temperature flammability limits; but has proved to be a greater fire hazard than kerosene fuels under handling and crush conditions. JP-4 contains about 75 percent alkanes and alkenes and about 25 percent monocyclic aromatics (toluene, with lesser amounts of benzene, ethylbenzene, and xylenes). It also contains 0.4 percent sulfur.

No. 4 and No. 6 ("Bunker C") Fuel Oil

These heavier oils are residual oils from the distillation of crude and consist of the heaviest hydrocarbon compounds, primarily alkenes and alkanes. They can contain substantial amounts of polycyclic aromatics, including the heavier polynuclear aromatic hydrocarbons (PNAs) such as anthracene, phenanthrene, and benzo(a)pyrene.

Hydraulic and Lubricating Oils

Hydraulic oils and lubricating oils contain some of the largest and most complex hydrocarbon molecules to be found in crude petroleum. Their molecular weight ranges from about 250 to 1,000 or more, based on structures containing 20 to 70 carbon atoms. They are usually composed of straight-chain paraffins, branched-chain paraffins, naphthalenes (one or more saturated 5- or 6-membered rings with paraffin side chains), aromatics, and mixed aromatic-naphthalenic-paraffinic chains. For some very special lubricating and hydraulic needs, as may be required in high-performance aircraft, synthetic lubricants are used. These synthetic lubricants are polyphenyl ethers, synthetic polymers, polyalkylene glycol oils, phosphate esters, dibasic acid esters, silicone oils, chloroflurorocarbons, silicate esters, and neopentyl polyol esters. The polyalkylene glycol oils are used as automotive hydraulic brake fluids. The dibasic acid esters and neopentyl polyol esters are used as lubricants in aircraft engines. The phosphate esters, the silicate esters, polyphenyl ethers, chlorofluorocarbons, and silicone lubricants are used as hydraulic fluids and lubricating oils in aircraft.

4.2.1.2 Composition of Solvents, Paints, Pesticides, and Acids

Several types of solvents, paints, pesticides, and acids have been used historically or are being used during normal operations at Selfridge ANGB. Degreasers and deicers, fuel additives, and battery acid are used for vehicle and aircraft maintenance; paint and associated varnishes, lacquers, strippers, and thinners are used to maintain base structures; and pesticides have been applied for weed and pest control.

Historical records indicate the primary degreasers used at Selfridge ANGB include acetone, methyl ethyl ketone, and two chlorinated solvents: trichloroethene and carbon tetrachloride. These solvents are all very light hydrocarbons with boiling points less that 100°C. The two chlorinated solvents have densities greater than water, which means these solvents may migrate below the water table. The primary deicer, ethylene glycol, has a density greater than water and also is soluble in water.

The paint products used at Selfridge ANGB include lacquers and varnishes. These are blends of hydrocarbons and natural resins which are soluble in alcohol, ethers, and other solvents. Strippers and thinners are highly volatile paraffins, esters, alcohols, ethers, or ketones used to remove paint or lacquers. They tend to vaporize easily. Lead, oil-based, and latex paints are complex mixtures of pigments, solvent resins, and dispersion resins. The solvent and dispersion resins may be hydrocarbon- or water-based. The pigments are many times based on metal-organic complexes of iron, copper, chromium, titanium, zinc, lead, nickel, or tin.

The pesticides DDT and chlordane belong to the family of chlorinated aromatic hydrocarbons. These hydrocarbons are multiple ring complexes with the chlorines attached to the rings. These compounds are not readily biodegraded and tend to remain in soil or water sediments for extended periods.

The acid used in automotive lead-based batteries is sulfuric acid. The concentration of the acid is approximately 30 percent.

4.2.1.3 Composition of Landfill Leachate

The records search determined that SWLF received demolition materials, residential waste, solvents (trichloroethene, carbon tetrachloride, methyl ethly ketone), paint strippers and thinners, and waste oils. The residential wastes and demolition wastes probably contained paper, plastics, wood, metal cans, cloth, food remnants, casings, concrete, and rebar. Approximately 5,900 tons of waste/per year were disposed from 1970 to 1978.

A similar records search found that TCLF received demolition materials, residential refuse, and industrial waste materials

such as carbon tetrachloride and trichloroethene. The demolition and residential waste was probably similar to that disposed in SWLF. During its active period from 1930 to 1955, refuse was often burned in the landfill.

NWLF was used for disposal of residential and industrial waste from 1955 to 1975. The industrial waste included solvents, paint thinners, paint strippers, waste oils, fuels, and tetraethyl lead fuel additives. The residential waste was probably similar to that disposed in SWLF.

As the climate in Michigan is humid continental to semimarine, with average annual precipitation of 28.07 inches, the buried refuse in the three landfills is subject to leaching by percolating water derived from rain or snowmelt. The result is landfill leachate. Table 4-4 is a list of representative ranges for various inorganic constituents in leachate from sanitary landfills. In addition, organic compounds have been identified in leachate-contaminated groundwater at many landfills throughout the country; however, specific summary ranges are not available. Many of the compounds appear to be derived by leaching of plastics and other discarded manufactured items within the refuse. Many times the leachate contains toxic constituents from liquid industrial waste.

In addition to the production of leachate, infiltration of water into refuse causes gases to be generated as biochemical decomposition of organic matter occurs. Gases such as CO_2, CH_4, H_2S, H_2, and N_2 are the most commonly observed. Methane (CH_4) and carbon dioxide (CO_2) are the most abundant.

Methane was detected in vapors from each of the landfills at Selfridge ANGB. These vapors may be produced by the landfills, but there are indications from borings around the base that natural methane exists in the sediments under the base.

4.2.2 Migration of Contaminants at Selfridge ANGB

The three classes of waste materials discussed in the previous subsections are stored, migrate, or decompose in the soils on base depending on their properties. Each of the waste materials' migration capabilities are discussed, beginning with hydrocarbon fuels and oils.

4.2.2.1 Migration of Hydrocarbon Fuels and Oils in Soil

In general, water is the primary solvent in the soils at Selfridge ANGB. However, if chemical constituents, particularly hydrocarbons, are released onto the soil surface in large enough quantities, they may enter the soil and replace water as the primary solvent in localized situations. This occurs regularly at FTA-2 and has occurred at ERMP and WRMP during fuel spills. The basic principles governing hydrocarbons migration

Table 4-4

Representative Ranges for Various
Inorganic Constituents in Leachate
from Sanitary Landfills,
IRP Stage 2, Selfridge ANGB, MI

Parameter	Representative Range (mg/L)
Potassium	200-1,000
Sodium	200-1,200
Calcium	100-3,000
Magnesium	100-1,500
Chloride	300-3,000
Sulfate	10-1,000
Alkalinity	500-10,000
Iron (total)	1-1,000
Manganese	0.01-100
Copper	<10
Nickel	0.01-1
Zinc	0.1-100
Lead	<5
Mercury	<0.2
Nitrate	0.1-10
Ammonium	10-1,000
Phosphate	1-100
Organic nitrogen	10-1,000
Total dissolved organic carbon	200-30,000
COD (chemical oxygen demand)	1,000-90,000
Total dissolved solids	5,000-40,000
pH (units)	4-8

Sources: Griffin, et al., 1976; Leckie, et al., 1975.

(which includes solvents, fuels, and oils that contain predominantly carbon-based compounds) are generally the same ones governing water migration in soils. However, because most hydrocarbons are not miscible with water, the relationships are more complex. The primary factors influencing hydrocarbons infiltration in soil are:

- Gravity -- The force that provides the energy for migration.

- Permeability -- A property determined by the soil composition and the depth of the saturated zone.

- Moisture content -- The amount of moisture in the soil and the depth of the saturated zone.

- Composition -- The chemical composition of the hydrocarbons which determines its density, surface tension, and viscosity.

The speed and the distribution pattern of the hydrocarbons migration into the soils at Selfridge ANGB will vary depending on these factors. In general, hydrocarbons released at the soil surface will penetrate through the soil surface via the most permeable path. In the case of large hydrocarbons spills, such as the fire training pits, maximum lateral spreading and downward flow occur with all soil pores being saturated with hydrocarbons (see Figure 4-21). However, if soil macropores exist, the hydrocarbons may flow downward through these preferred paths with little saturation of the soils (see Figure 4-22).

This situation could often occur at fuel lines or fuel tanks near WRMP and ERMP. The downward migration of hydrocarbons will be interrupted by one of three events at Selfridge ANGB:

- The hydrocarbons will be absorbed by the soil and become residual saturation.

- The hydrocarbons will encounter an impermeable bed.

- They will encounter the capillary fringe above the saturated zone (API Publication, 1628).

The subsurface of Selfridge ANGB must be examined to get some idea of which of these events will occur and in which order. Cross sections of the subsurface are diagramed and discussed in Subsection 4.1.1.2. In general, the first few feet is fill material followed by silty clays of lacustrine origin which increase in moisture content until the saturated zone. The saturated zone occurs at 7 to 14 feet. Discontinuous lenses of silt and sand are found throughout the lacustrine clay. In the western and southern parts of the base the lacustrine deposits grade to silty sands of shoreline and alluvial origin. The lacustrine clay continues until about 25 to 30 feet BLS where

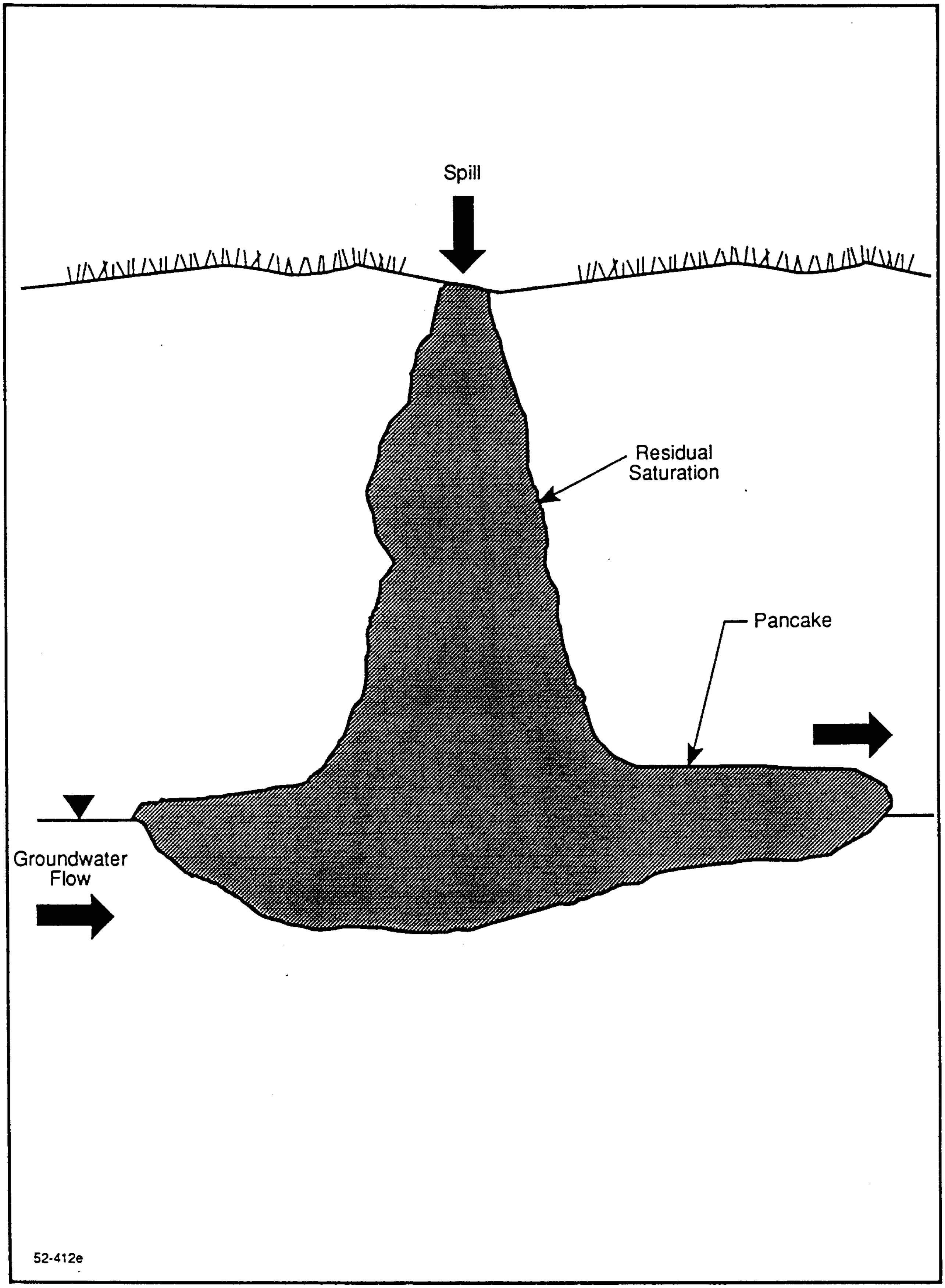


FIGURE 4-21 TYPICAL HYDROCARBONS DISTRIBUTION RESULTING FROM A MAJOR SPILL (ADAPTED FROM DRAGUN, 1988)

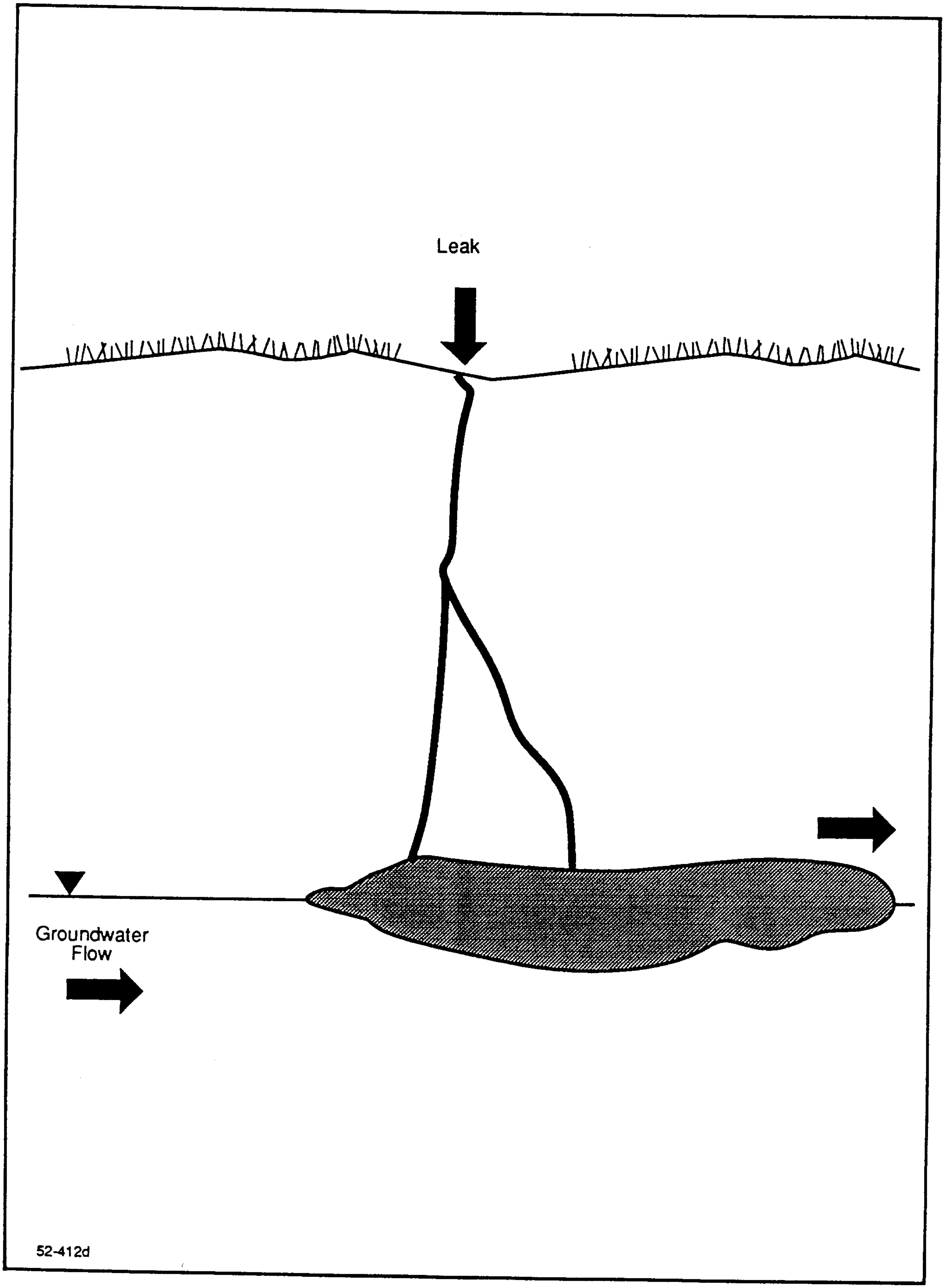


FIGURE 4-22 TYPICAL HYDROCARBONS DISTRIBUTION RESULTING FROM A SLOW LEAK INTO SOIL MACROPORES (ADAPTED FROM DRAGUN, 1988)

reworked glacial till or dense glacial till is encountered. The glacial till is a dry, slightly clayey, silty sand. Therefore, migrating hydrocarbons will encounter three barriers in the first 30 feet of migration downward into the soil:

- The lacustrine clay.
- The saturated zone.
- The dense glacial till.

The lacustrine clay has the capacity to adsorb large quantities of chemical constituents as residual saturation. It acts as a relatively impermeable bed and may prevent some releases of waste materials from reaching the saturated zone.

A significant proportion of the fuels spilled at Selfridge ANGB will have their migration halted by adsorption to the soil particles as residual saturation in the vadose zone. This residual saturation will remain adsorbed to the soil until it is chemically or biologically degraded or until it is remobilized by vaporization or migrating fluids (such as additional hydrocarbons or groundwater). The volume of soil required to immobilize the hydrocarbons in the soil as residual saturation depends upon the porosity of the soil and the physical properties of the hydrocarbons. The cubic yards of soil required to immobilize a volume of hydrocarbons (V_{hc}) can be grossly estimated by equation (1):

$$V_s = 0.2\ V_{hc}/P(RS) \qquad (1)$$

where,

V_s = Cubic yards of soil required to attain residual saturation.

V_{hc} = Volume of discharged hydrocarbons, in barrels (44 gallons = 1 barrel).

P = Soil porosity.

RS = Residual saturation capacity.

The residual saturation capacity of soils is about 33 percent of their water-holding capacity, in volume. Therefore, the maximum residual saturation capacity (RS) for light oil and gasoline is 0.1; for diesel and light fuel oil 0.15; and for lube and heavy oil 0.20 (Dragun, 1988). If the clay soils of Selfridge ANGB have an effective porosity of 0.15, then the number of cubic yards required to attain residual saturation (V_s) is 13.3 cubic yards for 1 barrel of gasoline. For diesel and fuel oil, the V_s is calculated to be 8.9 cubic yards for 1 barrel spilled. For lubricating and heavy oils, the V_s is calculated to be 6.7 cubic yards for 1 barrel spilled. Since JP-4 is a mixture of gasoline and kerosene, the residual saturation capacity (RS) for JP-4 will be about 0.125 and, therefore, the V_s is calculated to be 10.7 cubic yards.

Once the volume of soil required to attain residual saturation is calculated, the maximum possible depth of penetration (D), in yards, can be grossly estimated using equation (2):

$$D = V_s/A \qquad (2)$$

where,

A = The area of infiltration.

Another equation (3) for estimating the maximum depth of penetration of a volume of hydrocarbons released on a soil is:

$$D = RV_{hc}/A \qquad (3)$$

where,

R = A constant dependent upon the soil's retentive capacity for oil and upon oil viscosity (see Table 4-5).

From these equations it is possible to estimate the minimum volume of hydrocarbons necessary to enable a spill to reach the saturated zone before it is immobilized by the soil as residual saturation (Dragun, 1988).

Historical records indicate up to 6,000 gallons of JP-4 (136.36 barrels) have been spilled at both ERMP and WRMP at Selfridge ANGB. The cubic yards of soil required to attain residual saturation (V_s) from this volume of JP-4 is calculated to be 1,454.5 cubic yards using equation (1). If the spill occurred over a 100-square yard area, then by equation (2) it will penetrate to a maximum depth of 14.5 yards. Using equation (3) to calculate for depth and assuming the constant K will be about 10 for clay and silt, the spill of 6,000 gallons will penetrate to a maximum depth of 13.6 yards. The water table at Selfridge ANGB is at 2 to 3 yards BLS. Therefore, based on these equations, a large portion of the 6,000 gallons of JP-4 probably penetrated to the water table and formed a hydrocarbons pancake on the capillary fringe. If the 6,000 gallons were spilled at different times and at separate areas of the ramps, the depth of penetration of each spill will depend on its volume and the area of the spill. Based on these calculations, a spill as small as 1,600 gallons over a 100-square yard area will easily reach the water table.

Conversations with base fire department officials indicate that 8 to 12 fire training exercises are conducted per year. During each exercise 350 to 500 gallons are pumped onto the bermed pit at FTA-2, of which 20 to 30 percent remains as residual after the exercise. This means a range of 560 to 1,800 gallons are left as residual in the pit each year to volatilize, degrade, or be adsorbed into the ground. The bermed pit has an approximate radius of 60 feet (20 yards) and an area of 1,257 square

Table 4-5

Typical R Values for Various Soil Textures, IRP Stage 2, Selfridge ANGB, MI

Soil Texture	R Gasoline	R Kerosene	R Light Fuel Oil
Stone and coarse gravel	400	200	100
Gravel and coarse sand	250	125	62
Coarse and medium sand	130	66	33
Medium and fine sand	80	40	20
Fine sand and silt	50	25	12

Adapted from Dragun, 1988.

yards. Based upon equations (1), (2), and (3), the depth of penetration for the JP-4 before being halted by soil adsorption to residual saturation would range from 0.11 yards to 0.35 yards.

These calculations assume the residual JP-4 will be spread out evenly throughout the entire area of the pit after each exercise. As each fire training exercise involves extinguishing the fire by spraying the area with fire retardant, this may not be true. The area of soil absorption may be much smaller for each exercise and, therefore, the penetration deeper. Fire retardant (water) and annual precipitation will transport the hydrocarbons deeper into the soil. Migration may occur through soil macropores, with deeper penetration. Even not considering these factors, however, it can be assumed that each year of fire training activity adds an additional load of hydrocarbons to the soil. This pit has been active for 20 years. If an equivalent amount of soil is saturated each year, the depth of soil saturated calculates to be between 2.0 and 6.5 yards. Therefore, over time, the soil under FTA-2 has probably been saturated to the water table.

When hydrocarbons that are less dense than water (non-aqueous phase liquids -- NAPLs) reach the saturated zone, they will spread out laterally at the saturated zone to form pancakes or pools on the capillary fringe. This pancake can move up and down with the seasonal changes of the saturated zone (see Figure 4-23). Hydrocarbons will dissolve into the saturated zone from the pancake according to each constituent's solubility and move with the groundwater flow as contamination plumes. As the hydrocarbons stored as residual saturation in the vadose zone are remobilized by seasonal fluctuations in the water table or recharge water from precipitation, contamination plumes form in the groundwater from these hydrocarbons as well. Therefore it is probable that contamination plumes are formed in groundwater at spill locations at WRMP, ERMP, FTA-2, and possibly FTA-1.

4.2.2.2 Migration of Solvents, Paints, Pesticides, and Acids in Soil

The second class of waste materials (solvents, paints, pesticides, and acids) are primarily specialty chemicals that are derived from hydrocarbons or other natural substances. The battery acid is soluble in water and will quickly react with moisture in the soil and dilute, leaving sulfate residuals. If the soil moisture content of the soil is insufficient to dilute the acid, the great capacity of clays to act as a buffer will quickly neutralize the acid.

The oil-based paints and pesticides are large, complex organic compounds that will behave much like heavy hydrocarbon oils. It is not known how much of these compounds were disposed in the base landfills. If the quantity was large enough, they may have left residual saturation in the soils and formed pancakes on the capillary fringe of the water table. Their solubility

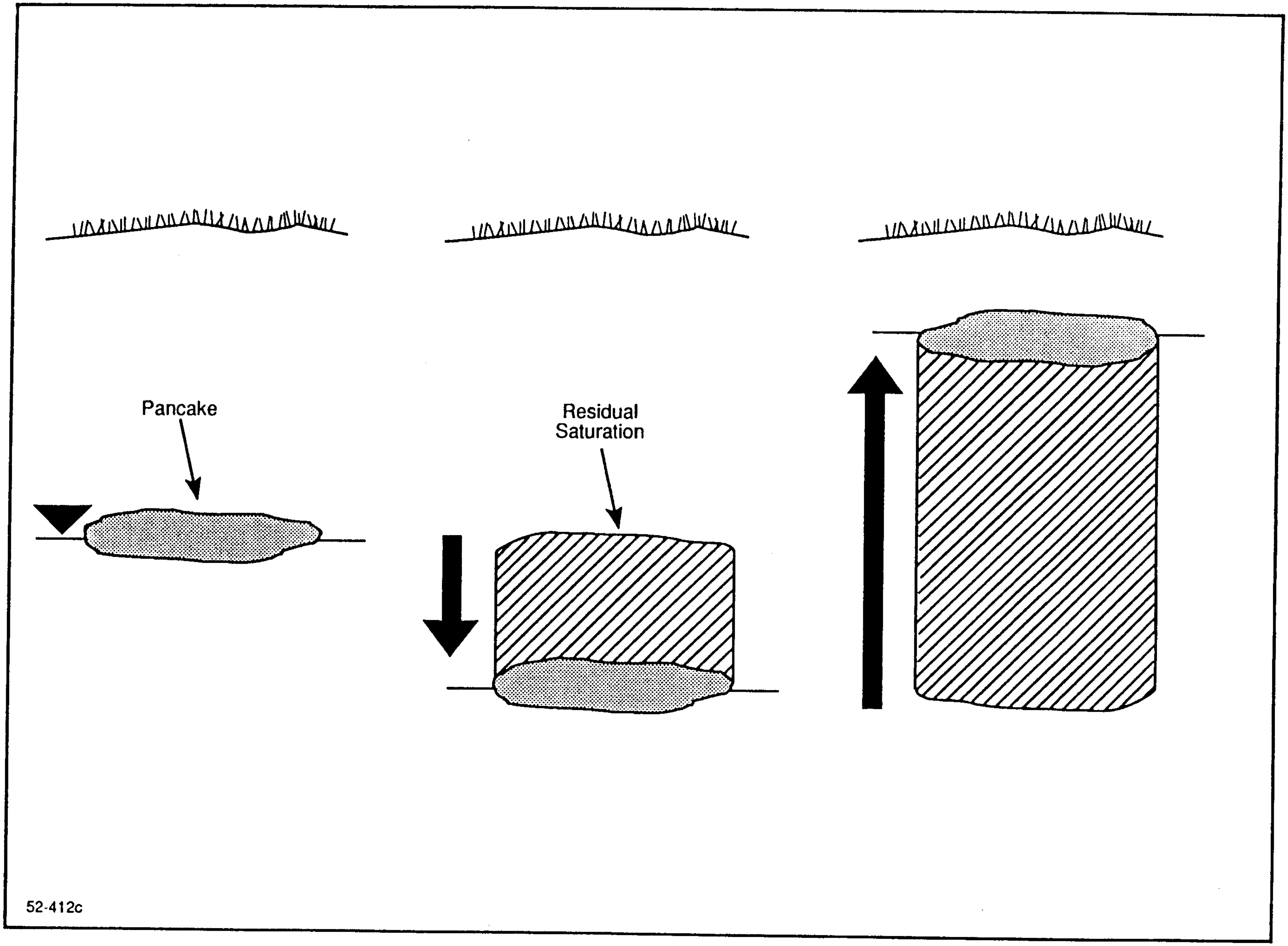


FIGURE 4-23 TYPICAL FLUCTUATION OF A WATER TABLE AND A PANCAKE OF HYDROCARBONS (ADAPTED FROM DRAGUN, 1988)

in water is low, but they do form contaminant plumes in groundwater in a similar fashion to hydrocarbons. The latex paints are water-based and will dissolve in water, except for the inorganic pigments formed from metal complexes. These pigments will interact with the clay molecules of the soils in cation-exchange reactions. These materials were disposed in the landfills and will contribute to the overall character of the leachate in the landfills.

The solvents used at Selfridge ANGB belong to the group of chemicals that are more dense than water (dense, non-aqueous phase liquids -- DNAPLs). These chlorinated compounds behave in a very similar fashion to hydrocarbon fuels and oils in the unsaturated zone. If spilled in large quantities, they will migrate through the soil, leaving residuals adsorbed to the soil as residual saturation. The quantities of soil required to immobilize the solvents as residual saturation are equivalent to or greater than the amount of soil required to immobilize gasoline (10 cubic yards per 44 gallons gasoline).

Because many of the solvents have lower viscosities (see Table 4-6) than water, hydrocarbon fuels, or oils, they can migrate even more readily through soil pores and macropores than the aforementioned compounds. A relatively small amount of solvent spilled can reach the water table. When a DNAPL reaches the saturated zone, it will spread laterally at the saturated zone to form a small pancake until the DNAPL attains sufficient mass (or hydraulic head) to penetrate the water surface and continue migration downward (Dragun, 1988). Work by Schwille (1985) and Farquhar (1988) has shown that the migration of the DNAPL into the saturated zone will then depend on the nature of the aquifer. If the aquifer is a dense clay, the DNAPL will migrate downward through fractures and macropores. If the aquifer is permeable, such as sand or gravel, the DNAPL will migrate rapidly through the aquifer until it is adsorbed by the soil or it reaches an impermeable bed. The direction of groundwater flow will not affect its downward migration. Any DNAPL not adsorbed by the soil will then follow the slope of the impermeable bed and flow downward until it is caught in depressions on the surface of the impermeable bed to form shallow pools or to find new pathways (such as cracks in fractured bedrock or macropores) to continue its downward migration (see Figure 4-24). The low viscosities of the DNAPLs enable them to migrate through sandy aquifers, clay and bedrock fractures, and soil macropores very rapidly. Contamination of the groundwater will, therefore, occur from a variety of ways that DNAPLs are retained in the subsurface:

- DNAPL residual saturation in the vadose zone.
- DNAPL residual saturation in the saturated zone.
- DNAPL pools in the saturated zone formed on discontinuous impermeable beds.

Table 4-6

Physical and Chemical Properties of Halogenated Solvents, IRP Stage 2, Selfridge ANGB, MI

Chemical	Solubility (mg/L)	Solubility T(°C)	Density (g/cm^3)	Density T(°C)	Kinematic Viscosity (cP)	Kinematic Viscosity T(°C)	Vapor Pressure (mm Hg)	Vapor Pressure T(°C)	Melting Point (°C)
Chloroform	8,200	20	1.50	15	0.60	15	150	20	-64
Carbon tetrachloride	785	20	1.58	20	0.97	20	90	20	-23
Chlorobenzene	500	20	1.11	20	0.80	20	10	20	-45
1,2-Dichlorobenzene	145	25	1.30	25	1.32	25	1.5	25	-17
1,3-Dichlorobenzene	123	25	1.28	25	1.04	25	2.3	25	-25
1,1-Dichloroethane	5,500	20	1.18	15	0.51	25	180	20	-97
1,2-Dichloroethane	8,690	20	1.26	15	0.89	15	61	20	-35
1,1-Dichloroethene	400	20	1.27	25	0.44	25	591	25	-122
trans-1,2-Dichloroethene	600	20	1.25	20	0.40	20	200	14	-50
Dichloromethane	20,000	25	1.33	20	0.45	20	362	20	-95
1,1,1-Trichloroethane	4,400	20	1.35	20	0.90	15	96	20	-30
1,1,2-Trichloroethane	4,500	20	1.44	20	0.13	20	19	20	-37
1,1,2,2-Tetrachloroethane	2,900	20	1.60	15	1.84	15	5	20	-36
Trichloroethene	1,100	20	1.47	20	0.57	20	58	20	-73
Tetrachloroethene	200	20	1.63	15	1.93	15	14	20	-23
Water	---	---	1.00	4	1.01	20	17	20	0

Adapted from Cherry, 1988.

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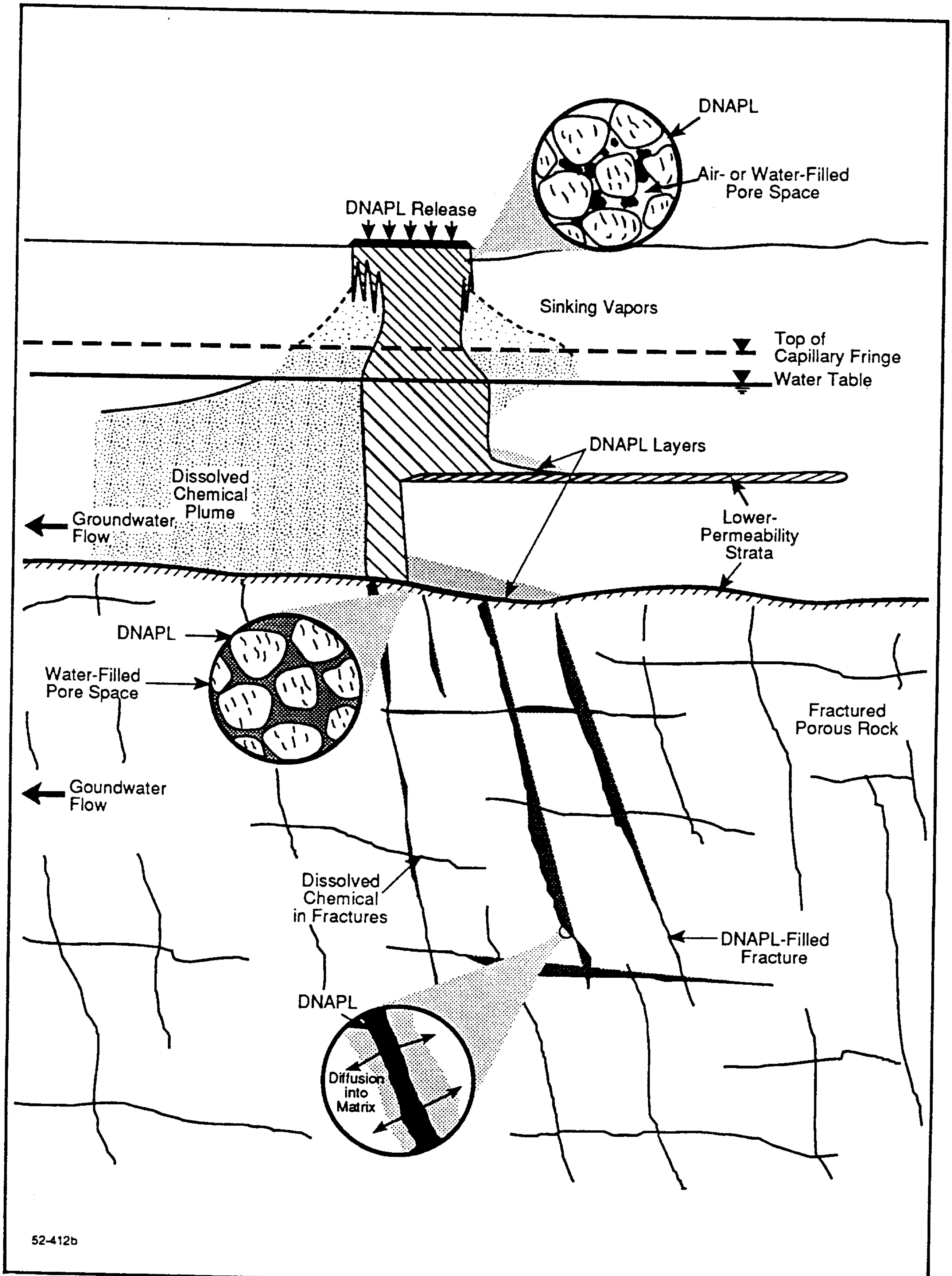

FIGURE 4-24 TYPICAL MIGRATION OF DENSE NONAQUEOUS PHASE LIQUIDS (DNAPLS) IN OVERBURDEN AND FRACTURED BEDROCK (ADAPTED FROM CHERRY, 1988)

- DNAPL pools in the saturated zone formed in depressions of continuous impermeable beds.

- DNAPLs in fractures of clay or fractures in bedrock.

As most DNAPLs are relatively insoluble in water (saturation concentration less than 1 percent, see Table 4-6), they are not readily removed in large quantities by groundwater from the subsurface. However, DNAPLs will form plumes in groundwater which move through the soils or bedrock permeated with residual DNAPL saturation, or in groundwater that flows over pools of DNAPLs collected on impermeable beds. Records indicate that several sites at Selfridge ANGB have been used for disposal of DNAPLs such as carbon tetrachloride and trichloroethene -- namely, SWLF, TCLF, and NWLF -- and the presence of DNAPLs has been documented at these sites. However, the amounts of these DNAPLs put in the landfills are unknown, which makes it difficult to estimate the depth of migration.

4.2.2.3 Migration of Landfill Leachate in Soil

The third class of waste material, landfill leachate, is not strictly a manmade contaminant of the soil, but rather a contaminant formed by natural processes acting on buried, manmade waste. It can be composed of many inorganic and organic constituents, all of which are dissolved in water. The migration of leachate in the vadose zone is controlled by the physical processes affecting water percolation -- gravity, permeability, and moisture content. In the saturated zone, leachate merges with and is eventually indistinguishable from groundwater. The migration of specific constituents is controlled by chemical reactions as discussed in the following subsection.

4.2.2.4 Migration of Waste Materials in Groundwater

The migration of dissolved hydrocarbons, solvents, paints, pesticides, and landfill leachate through the soil depends on the movement of recharge water through the vadose zone and groundwater through the saturated zone. As discussed in Subsection 2.7, the climate of Selfridge ANGB is classified as humid continental to semimarine. The annual precipitation of Selfridge ANGB is 28.07 inches, with evapotranspiration being about equal, resulting in a net surplus of 0 to 5 inches of water. Therefore, 0 to 5 inches of water migrate into the soil to the saturated zone per year. This represents a very small amount of water available to move chemicals through the unsaturated zone relative to the amount of groundwater that is available to move chemicals through the saturated zone.

The migration of the contaminants through the saturated zone depends on the permeability of the soils. Hydraulic conductivities determined at Selfridge ANGB range from 1.11×10^{-3} cm/sec (silty sand) to 1.72×10^{-6} cm/sec (clay and glacial till), with a mean of 1.349×10^{-4} cm/sec. This range reflects the discontinuous beds of silt and sand in the clays and

the alluvial nature of the soils in the southwestern portion of the base, as well as the soil macropores. Approximately 75 percent of the hydraulic conductivities are within the range of 1.100×10^{-5} cm/sec to 8.812×10^{-5} cm/sec.

The ability of groundwater to transport contaminants through the subsurface is limited by the ability of soils to adsorb and retain chemical constituents. Each type of soil can adsorb chemical constituents to a greater or lesser degree depending upon the soil's mineralogy. Soil mineralogy governs structure properties such as molecular size, hydrophobicity, molecular charge, the presence of organic molecular fragments that undergo hydrogen bonding, the three-dimensional arrangement and interaction of molecular fragments, and the presence of molecular fragments that undergo coordination bonding. These properties, in turn, govern the ability of soils to adsorb and retain molecules. The lacustrine silty clays of Selfridge ANGB are particularly able to adsorb chemical constituents because of their layered nature with a high degree of coordination bonding, hydrogen bonding, and molecular charge and the presence of organic carbon in the clays. The effect of these properties can be summarized by the adsorption or distribution coefficient K_d. K_d can be mathematically defined by equation (4) as the ratio:

$$K_d = C_s/C_e \qquad (4)$$

where,

C_s = Concentration adsorbed on soil surfaces (ug/g soil).

C_e = Concentration in water (ug/mL).

The greater the extent of adsorption (i.e., $C_s >> C_e$), the greater the magnitude of K_d. Each type of soil, whether it be clay, silt, or sand, will have its own characteristic K_d.

Most natural soils contain natural organic matter. This organic matter is intimately bound to clay as a clay-organic complex. As a result, two major types of adsorbing surfaces are available to migrating chemicals: clay-organic, and clay alone. Many times researchers normalize K_d values on the basis of the soil's organic matter or organic carbon content. When this is done, much of the variation observed among K_d values over different soils is eliminated. Normalized K_d values are expressed by equation (5) as either K_{om} or K_{oc}:

$$K_{om} = K_d/_{om} \text{ or } K_{oc} = K_d/_{oc} \qquad (5)$$

where,

K_{om} = Soil adsorption coefficient normalized for soil organic matter content.

K_{oc} = Soil adsorption coefficient normalized for the soil organic carbon content.

om = The soil organic matter content (mg organic matter /mg soil).

oc = The soil organic carbon content (mg organic carbon /mg soil).

The relationship between om and oc is assumed to be constant: $K_{oc} = 1.724\ K_{om}$

Measured K_{oc} and K_{om} values for some of the organic chemical constituents of concern at Selfridge ANGB are listed in Table 4-7. Ranges of K_d values for inorganic constituents of concern to Selfridge ANGB are listed in Table 4-8. The relative relationships of K_d, K_{oc}, and K_{om} and mobility are compared in Table 4-9.

Once the K_d value for a chemical is known, the most commonly accepted and utilized equation for grossly estimating the migration rate of a chemical in a soil-groundwater system is the retardation equation (6) (Dragun, 1988):

$$V_c = V[1 + K_d(b/P_t)]^{-1} \qquad (6)$$

where,

V_c = The velocity of the chemical at the point where $c/c_o = 0.5$.

V = Average linear velocity of groundwater.

K_d = Distribution coefficient.

b = Soil bulk density.

P_t = Soil total porosity.

The retardation equation can be modified for use in estimating the migration rate (V_c) of a chemical in unsaturated zone soil (equation (7)):

$$V_c = V_{sw}(WC + bK_d)^{-1} \qquad (7)$$

where,

V_{sw} = Amount of soil water percolating through the unsaturated zone (inches/year).

WC = Soil water content.

b = Soil bulk density.

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Table 4-7

Measured K_{oc} and K_{om} Values for Various Organic Chemicals, IRP Stage 2, Selfridge ANGB, MI

Chemical	K_{oc}	K_{om}
Acetophenone	35	
Anthracene	26,000	
Benzene	83	18
Chlorobenzene		48
1,2-Dichlorobenzene	347	186
1,3-Dichlorobenzene		170
1,4-Dichlorobenzene		158
Ethylbenzene		95
cis-1,3-Dichloropropene	23	
trans-1,3-Dichloropropene	26	
2-Methylnaphthalene	8,500	
Naphthalene	1,300	
Nitrobenzene		50
Phenol	27	
Pentachlorophenol	900	
Pyrene	62,700-84,000	
1,1,2,2-Tetrachloroethane	79	
Tetrachloroethene	363	
Tetracene	650,000	
1,2-Dichloroethane	32	

Adapted from Dragun, 1988.

Table 4-8

Range of K_d for Various Elements in Soils and Clays, IRP Stage 2, Selfridge ANGB, MI

Element	Range (mL/g)	Mean[a]	Deviation[b]
Ag	10 - 1,000	4.7	1.3
As(III)	1.0 - 8.3	1.2	0.6
As(V)	1.9 - 18	1.9	0.5
Ca	1.2 - 9.8	1.4	0.8
Cd	1.3 - 27	1.9	0.9
Ce	58 - 6,000	7.0	1.3
Co	0.2 - 3,800	4.0	2.3
Cr(III)	470 - 150,000	7.7	1.2
Cr(VI)	1.2 - 1,800	3.6	2.2
Cu	1.4 - 333	3.1	1.1
Fe	1.4 - 1,000	4.0	1.7
K	2.0 - 9.0	1.7	0.5
Mg	1.6 - 13.5	1.7	0.5
Mn	0.2 - 10,000	5.0	2.7
Mo	0.4 - 400	3.0	2.1
Pb	4.5 - 7,640	4.6	1.7
Se(IV)	1.2 - 8.6	1.0	0.7
Tl	2,000 - 510,000	11.0	1.5
Zn	0.1 - 8,000	2.8	1.9

[a]Mean of the logarithms of the observed values.
[b]Standard deviation of the logarithms of the observed values.
Adapted from Dragun, 1988.

Table 4-9

Relationship of Mobility to K_d, K_{om}, and K_{oc}, IRP Stage 2, Selfridge ANGB, MI

Mobility Class	K_d	K_{om}	K_{oc}
I - Immobile	>200		>10 >2,000
II - Low Mobility	2- 10	60-200	500-2,000
III - Intermediate Mobility	0.5-2	20- 60	150- 500
IV - Mobile	0.1-0.5	5- 20	50- 150
V - Very Mobile	<0.1	<5	<50

Adapted from Dragun, 1988.
Based on values derived from soil with 2.5 percent organic matter.

Retardation equations (6) and (7) can be used for hydrocarbon fuels and oils, chlorinated solvents, pesticides, and metals. Each site on base has slightly different groundwater velocities, and the values for these equations will be different throughout the base. They are used to calculate contamination plumes for each site in the extent of contamination discussions in Subsections 4.4 through 4.11.

4.2.3 Removal of Contaminants from Soil by Natural Processes

After a spill or release has occurred, organic contaminants can be removed from the soil by several natural processes: diffusion and volatilization, chemical reaction with and within the soil, and biodegradation. These processes are discussed as follows. Although inorganic constituents are not generally removable from the soil, there are some reactions that serve to immobilize them with a relatively high degree of permanence. These reactions are also discussed in this subsection.

4.2.3.1 Diffusion and Volatilization

Diffusion can be defined as the average rate of migration or velocity of a constituent within one medium or from one medium to another. At Selfridge ANGB, the diffusion of organic constituents from soil to the atmosphere is significant with respect to the removal of contaminants from the subsurface. Diffusion is caused by the presence of a gradient across a boundary or within a medium. The gradient may be concentration, pressure, or temperature. Chemical constituents diffuse from higher concentration to lower concentration until an equilibrium is reached. For diffusion to stop, all three properties -- concentration, pressure, and temperature -- must be in equilibrium across the boundary or within the medium. Under normal circumstances in soil systems, only concentration diffusion is important. The extent of diffusion of a chemical constituent in soil depends on the nature of the chemical constituent, the type of liquid or waste it is in, the depth of burial, the porosity of the soil, the moisture content of the soil, the percentage of clay and organic matter in the soil, and the temperature and wind speed of the surrounding area.

Vapor pressure is a measurement of the ability of a chemical to diffuse into the atmosphere at a given temperature and pressure. Tables 4-6 and 4-10 list properties of chlorinated compounds and fuels, including vapor pressures. In general, chemicals with vapor pressures less than 10^{-7} mm Hg (torr) should be present in the atmosphere or soil air in negligible amounts. These chemicals would include higher carbon compounds of fuels and fuel oils. Those chemicals with vapor pressures greater than 10^{-2} mm Hg should be present primarily in the atmosphere or soil air. Some of the more volatile solvents such as methylene chloride and the lighter components of fuels

Table 4-10

Properties of Hydrocarbon Fuel Compounds, IRP Stage 2, Selfridge ANGB, MI

Formula	Name	Molecular Weight	Melting Point	Boiling Point	Vapor Pressure (25°C, mm Hg)	Aqueous Solubility (25°C, mg/L)
AROMATICS						
C_6H_6	Benzene	78	6	80	95	1,780
C_7H_8	Toluene	92	-95	111	29	535
C_8H_{10}	o-Xylene	106	-25	144	6.6	175
	m-Xylene	106	-47	139	8.0	200
	p-Xylene	106	13	138	8.6	200
C_8H_{10}	Ethylbenzene	106	-94	136	7	152
C_9H_{12}	Propylbenzene	120	-100	159	3.5	60
$C_{10}H_8$	Naphthalene	128	357	Sub	Solid at STP	32
$C_{12}H_{10}$	Biphenyl	154	70	256	0.056	7.5
C_6H_5OH	Phenol	94	43	181	0.62	89,000
ALKANES						
C_4H_{10}	Butane	58	-138	-1	1,734.6	79
C_5H_{12}	Pentane	72	-130	36	450.8	2
C_6H_{14}	Hexane	86	-95	68	133.3	---
C_6H_{12}	Cyclohexane	84	6	81	83.2	130
C_7H_{16}	Heptane	100	-91	98	41.7	50
C_8H_{18}	Octane	114	-56	125	13.6	16

Sub -- Sublimes.

have such vapor pressures. Those chemicals possessing vapor pressures between these two values may have a tendency to exist in both the atmosphere or in soil air, as well as in liquid or solid form. Many of the chemical constituents of gasoline and fuel oil have such vapor pressures.

The diffusion of a chemical in air is expressed by the diffusion coefficient D_A in cm^2/sec. The rates at which chemicals diffuse at a given temperature are inversely proportional to the square roots of their molecular weights. Diffusion coefficients in air for chemicals of interest at Selfridge ANGB are listed in Table 4-11.

Several equations have been derived to estimate the emissions rate of a chemical or chemicals spilled on a soil surface or buried in soil. In cases where the chemical or waste has been discharged or placed on the soil surface, the rate of vapor generation of the chemical for steady-state conditions can be estimated using equation (8):

$$E = 2P_V W_A (L_A D_A V/(3.1416)f)^{1/2} (W_C/W) \qquad (8)$$

where,

E = Emissions rate (cm^3/sec).

P_V = Equivalent vapor pressure (percent), where,

P_V = Vapor pressure (mm Hg)/760

W_A = Width of area occupied by the chemical/waste (cm).

L_A = Length of area occupied by chemical/waste (cm).

D_A = Diffusion coefficient of the chemical in air (cm^2/sec).

V = Wind speed (cm/sec).

W_C/W = Weight fraction of the chemical in contaminated soil/ waste (g/g).

f = Correction factor, where,

$f = (0.985 - 0.00775\ P_V)$, where the range of P_V is 0 to 80 percent.

The volumetric emissions rate (E) can be converted into a mass emissions rate by equation (9):

$$Q = E(MW)/G \qquad (9)$$

Table 4-11

Diffusion Coefficients in Air for Selected Chemicals, IRP Stage 2, Selfridge ANGB, MI

Chemical	D_a*	T**	Chemical	D_a*	T**
Acetic acid	0.133	25	Ethyl acetate	0.089	30
Ammonia	0.28	25	Ethyl alcohol	0.119	25
Benzene	0.088	25	Ethylbenzene	0.077	25
Biphenyl	0.061	0	Ethylene dibromide	0.070	0
n-Butyl alcohol	0.097	25.9	Ethyl ether	0.093	25
Butylamine	0.101	25	Formic acid	0.159	25
Carbon dioxide	0.164	25	Hexane	0.080	21
Carbon disulfide	0.107	25	Hexyl alcohol	0.059	25
Chlorobenzene	0.075	30	Hydrogen	0.410	25
Chlorotoluene	0.065	25	Methyl alcohol	0.159	25
Cyclohexane	0.086	45	n-Octane	0.060	25
Diethylamine	0.105	25	Oxygen	0.178	0
Diphenyl	0.068	25	n-Pentane	0.071	21
			Propionic acid	0.099	25
			n-Propyl alcohol	0.100	25
			n-Propylbenzene	0.059	25
			Toluene	0.088	30
			Water	0.220	0
				0.256	25
			Xylenes	0.071	25

* In cm^2/sec.
** In °C.
Adapted from Dragun, 1988.

where,

Q = Mass emissions rate (g/sec).

E = Volumetric emissions rate (cm^3/sec).

MW = Molecular weight (g/mole).

G = 24,860 cm^3/mole.

Toluene and octane make up significant portions of JP-4. Therefore, a calculation of their emissions rates using equation (8) should give an indication of how rapidly fuel will evaporate if spilled on a concrete or soil surface. The emissions rate of chlorobenzene will also be calculated as an example of a chlorinated solvent. Table 4-12 presents mass and volumetric evaporation rates from spills on concrete for these compounds. Table 4-13 presents mass and volumetric evaportation rates from spills on soil for these compounds.

Some experimental studies have examined the rate of evaporation when a chemical is mixed in water or waste or when the compounds are covered by soil. Such studies have determined that the evaporation of chemicals mixed in wastewater is dramatically different than a pool of pure product. Although for some solvents the evaporation rate may initially be greater when mixed than the evaporation rate of pure product, over time, the evaporation rate of the compound is reduced dramatically in a mixture.

Studies of the effect of burying compounds under soil cover have examined the effects of temperature and pressure on the rate of evaporation. Examination of the soil-atmosphere interface has determined that as soil temperature rises, air pressure increases in the soil and flow occurs to re-establish equilibrium. However, temperature changes are greatest at the soil surface and decrease exponentially with depth, so that the effects of temperature on gas exchange are limited to the upper few inches of soil.

On the other hand, if climatic conditions are favorable for the evaporation of soil water, as is the case at Selfridge ANGB, chemical volatilization could be enhanced by the "wick" effect. Soil water containing a dissolved chemical moves toward the soil surface by capillary action in response to water evaporation from the soil surface. The net result of the wick effect is an enhancement of chemical movement to the soil surface for subsequent volatilization. A similar effect occurs after a rainstorm, when water percolating into the soil remobilizes and replaces some of the soil air that contains the chemical constituents, which then are forced to the surface and which volatilize by evapotranspiration.

Table 4-12

Evaporation Rates for Spills on Concrete,
IRP Stage 2, Selfridge ANGB, MI

Compound	Area of Spill (m^2)	Emissions Rate (kg/hr)	(gal/hr)
Toluene	25	40.4	12.3
Octane	25	19.6	7.4
Chlorobenzene	25	14.2	3.4
Toluene	100	114.2	34.8
Octane	100	55.3	20.8
Chlorobenzene	100	40.2	9.6

Wind speed 10 mph.
Weight fraction equals 1 for all compounds.

Table 4-13

Evaporation Rates for Spills on Soil,
IRP Stage 2, Selfridge ANGB, MI

Compound	Area of Spill (m^2)	Emissions Rate (kg/hr)	(gal/hr)
Toluene	25	0.31	0.10
Octane	25	0.15	0.06
Chlorobenzene	25	0.11	0.03
Toluene	100	0.89	0.27
Octane	100	0.43	0.16
Chlorobenzene	100	0.31	0.07

Wind speed 10 mph.
Weight fraction equals 0.010 for toluene and octane and 0.0115 for chlorobenzene; based on densities of compound, density of soil (2.1 g/cc), and compound-specific residual saturation capacities of soil.

An approach to estimating the emissions rate of volatile chemicals from soil beneath a clean soil cover is given by equation (10) (Dragun, 1988):

$$E = fD_AC_{SV}AP_T^{4/3}(L)^{-1}(W_c/W) \qquad (10)$$

where,

E = Emissions rate of the chemical (g/sec).

f = Emissions rate enhancement factor, where,

$f = 6$ to 7 if sweep gas is being produced, and

$f = 1$ under normal conditions.

D_A = Diffusion coefficient of the chemical in air (cm^2/sec)

A = Exposed area (cm^2).

P_T = Soil total porosity (dimensionless fraction).

L = Effective depth of soil cover (less than or equal to 35 cm).

W_c/W = Weight fraction of the chemical in contaminated soil/waste beneath the soil cover (g/g).

C_{SV} = Saturated vapor concentration (g/cm^3), where,

$C_{SV} = V_p$ (MW)/RT, where,

V_p = Vapor pressure (mm Hg).

MW = Molecular weight (g/mole).

$R = 6.23 \times 10^4$ mm Hg cm^3/mole °K.

T = Temperature (°K).

Equation (10) was originally derived to estimate hexachlorobenzene emissions through the soil cover of a landfill. An analysis of equation (10) will reveal that diffusion is assumed to be the only transport process operating, and that a given concentration of the chemical will volatilize, resulting in a saturated vapor concentration. The vapor then diffuses through the soil cover at a rate determined by the diffusion coefficient, the cover depth, and the porosity. Toluene, octane, and chlorobenzene will be used to illustrate the potential evaporation of volatiles from buried sources at Selfridge ANGB. These

calculations, presented in Table 4-14, show the effects of the wick effect caused by evapotranspiration (emissions rate enhancement factor = 6). These calculated emissions rates, which are significantly lower than for spills, represent maximum values that will decrease with time as volatile constituents are removed from the soil into the atmosphere.

Even knowing these evaporation rates, it is very difficult to estimate the percentage of a spill that will vaporize because of the number of variables that can affect volatilization at an individual site. At FTA-2 approximately 100 gallons of waste JP-4 is not burned during a fire training exercise. The fuel probably spreads out over at least a 100-square meter area after it has been sprayed with fire retardant (water). From observations by WESTON personnel it is known that it may take as long as 72 hours for all the residual fuel and water to soak into the ground after a fire training exercise. The bulk of the residual fuel is probably exposed directly to the atmosphere for at least 5 to 10 hours. Initially it will vaporize at an average of about 28 gallons/hour (average rate from toluene and octane emissions rates per 100-square meter area). However, when fuels are mixed with water, it has been shown that the rate is reduced by at least a factor of ten within a relatively short period of time (60 to 200 minutes). Therefore, during the first 10 hours it is exposed to the atmosphere, the spill is calculated to lose more than half its volume by vaporization (28 gallons + 25 gallons = 53 gallons). The remaining JP-4 will vaporize at a much lower rate at FTA-2. This rate can not be accurately calculated because of a number of complexing factors:

- The major, very volatile portions of JP-4 will evaporate during the initial hours of the spill.
- The migration rate through the top layer of soil is probably artificially fast because of the hydrocarbons-soaked nature of the soil which increases the soil's effective porosity or hydraulic conductivity.
- The rapid transport through the upper layers of soil will result in much reduced emissions rates through the soil cover.

These calculations indicate that a major portion (>50 percent) of fuels or solvents spilled are removed by vaporization.

4.2.3.2 Organic Chemical Reactions in Soil

Many organic chemicals in soils systems are degraded through one or more abiotic chemical reactions. These reactions are those that do not involve metabolically active microorganisms or intermediates or extracellular enzymes. In general, five organic chemical reactions are known to occur in soil systems:

Table 4-14

Evaporation Rates from Beneath a Soil Cover,
IRP Stage 2, Selfridge ANGB, MI

Compound	Area of Source (m^2)	Emissions Rate (kg/hr)	Emissions Rate (gal/hr)
Toluene	25	0.043 0.0072*	0.0130 0.0022*
Octane	25	0.017 0.0028*	0.0064 0.0011*
Chlorobenzene	25	0.014 0.0093*	0.0033 0.0006*
Toluene	100	0.017 0.029*	0.0524 0.0087*
Octane	100	0.068 0.011*	0.0256 0.0043*
Chlorobenzene	100	0.057 0.0094*	0.0134 0.0022*

*Without wick effect of water evapotranspiration.
Wind speed 10 mph.

- Reduction.
- Hydrolysis.
- Substitution.
- Elimination.
- Oxidation.

Reduction of Organic Chemicals

Reduction is an increase in the number of electrons attached to an ion or molecule. Reduction appears to be the least studied and understood chemical reaction that occurs in soil, which is surprising, considering that soil-groundwater systems are generally anaerobic systems that should be especially capable of mediating reduction reactions. In general, an organic chemical will undergo chemical reduction if the electrical potential of the soil system is less than that of the chemical in question. Although these conditions may occur frequently in Selfridge ANGB landfills, it is not known whether reduction of organic chemicals is an important reaction at Selfridge ANGB.

Hydrolysis of Organic Chemicals

Hydrolysis is a chemical reaction during which an organic chemical reacts with water or a hydroxide ion to form a hydrolyzed organic compound. This occurs when a proton-attracting group (H_2O or $OH^{(-)}$) attacks an electron-attracting group and displaces a leaving group. The rates of hydrolysis in soil are quite variable depending on the pH of the soil particle surfaces, the presence of metals in the soil, the adsorption of the organic chemical, and the soil water content.

In general, organic molecules and fragments that are susceptible to hydrolysis at Selfridge ANGB are chlorinated solvents. The fuels used at Selfridge ANGB are composed of alkanes, cycloalkanes, or aromatics, which are usually not attacked by hydrolysis (Dragun, 1988). Hydrolysis half-lives of chlorinated compounds range from days to years.

Substitution and Elimination Reactions of Organic Chemicals

Hydrolysis is a substitution reaction as it substitutes H_2O/$OH^{(-)}$ ions for leaving groups. Other substitution reactions can occur to halogenated alkanes in a reduced groundwater system containing hydrogen sulfide. These types of conditions may occur in landfills, swamps, wetlands, or dumps.

Elimination reactions involve the loss of two leaving groups from adjacent atoms within a molecule. The loss results in the formation of a new double or triple bond. Commonly, the two leaving groups are halogens, such as in 1,2-dibromoethane and 1,2-dibromopropane, which have been observed to eliminate HBr in water at pH 7 to yield vinyl bromide and bromopropenes.

The reaction rate constants for these reactions in soil systems generally have not been studied or reported in the published literature. As with hydrolysis reactions, the nature of the soil surface, the presence of metals in the soil, the adsorption of the organic chemical, and the soil water content all affect the rate of the reactions, although to what extent is unknown. It is uncertain whether these reactions occur at landfills at Selfridge ANGB and to what extent. However, some of the common reaction products of elimination have been detected in the landfills (e.g., vinyl chloride).

Oxidation of Organic Chemicals

Oxidation is a decrease in the number of electrons attached to an ion or molecule. This reaction is reversible and may happen in soil systems by thermal dissociation, disruption of molecules by radiant energy, disruption by high-energy particles or electrons (alpha or beta radiation), or single-electron transfer to structures of elements that have incomplete inner electron shells (such as those elements bound in layer lattice silicates in soils and clays). Oxidation results in the formation of a free radical, which, in turn, reacts with another organic molecule to form another free radical or an organic reaction product. Because radical cations are electron-deficient species, electron-donating substitutes (e.g., aromatics, ketones, amides) are more susceptible to attack by radical cations. Phenols, naphthalene, ethylbenzene, and benzene, which are contaminants at Selfridge ANGB, undergo these reactions.

Soils, clays, and minerals possess the ability to catalyze chemical oxidation of many chemicals at ambient pressure and temperature. Iron, manganese, aluminum, and trace metals within soil minerals have been identified as oxidation catalysts in soils and clay. However, the reaction rates for oxidation in soil systems have, in general, not been studied or reported in the literature. Therefore, although chemical species that undergo chemical oxidation are contaminants at Selfridge ANGB, it is unknown how this reaction affects their presence.

4.2.3.3 Biological Degradation

Soil serves as the home for numerous microorganisms capable of degrading organic chemicals. The microorganisms are both plant and animal. The plant population does the bulk of the degradation, although the animal population affects the biology and chemistry of the soil significantly. The plant microorganisms include bacteria, actinomycetes, fungi, and algae. The biodegradation of an organic chemical is the modification or decomposition of the chemical by soil microorganisms to produce, ultimately, microbial cells, carbon dioxide, and water. The microorganisms degrade the chemical by the use of enzymes that metabolize the chemical for the organism.

There are two basic definitions for biodegradation. Primary degradation is any biologically induced structural change in an organic chemical. Thus, organic chemical biodegradation rates, reported in terms of the removal, disappearance, or loss of the initial chemical over time, refer to primary degradation. Ultimate degradation is the biologically mediated degradation of an organic chemical into carbon dioxide, water, oxygen, and other inorganic products of metabolism. Biodegradation rates, reported in terms of BOD, COD, oxygen uptake, methane or carbon dioxide evolution, or loss of dissolved organic carbon, refer to ultimate degradation.

The power rate law is used to calculate primary degradation rates. It states that the biodegradation rate of an organic chemical is proportional to the organic chemical's concentration. Biodegradation rates for many organic chemicals are first-order with respect to the organic chemical's concentration. As a result, rate constants and half-lives can be calculated.

Ultimate degradation rates are calculated using hyperbolic rate law based on Monod kinetics. It states that the growth rate of a single-species or mixed-species population of microorganisms, utilizing one organic chemical as an energy source, is dependent upon chemical concentration and the growth rate of the microorganism.

The biodegradation rate of an organic chemical is generally dependent upon the presence of soil microorganisms capable of degrading the chemical and the number of these organisms in the soil system. Microorganism population is greatest in the surface horizons of soil. This is especially true of very fine soils, such as the lacustrine silts and clays of Selfrdige ANGB. In the surface horizons, soil temperature, moisture, aeration, and energy supply are at relatively more favorable levels for supporting microorganisms.

The other factors affecting biodegradation include the acidity and alkalinity of the soil and the adsorption properties of the soil system. According to Leibig's Law of the Minimum, the rate of a biological process is limited by the factor present at its minimum value. Therefore, all of these factors can drastically reduce the effectiveness of biodegradation if they are not at or near optimum.

The majority of soil microorganisms will thrive in a pH range of 6 to 8. Most will tolerate a pH range of about 4 to 9. Strong acid or alkaline conditions will inhibit the growth and metabolism of most soil microorganisms. Temperature and moisture extremes have similar effects on microbial growth as extremes in pH. Microorganisms thrive in soils or groundwater above freezing point of water and below 50°C. Groundwater temperatures in the contiguous United States usually fall within these ranges. Very dry conditions decrease microbial growth,

and very wet conditions decrease the availability of energy sources, causing reduction of microbial growth.

The degradation of organic chemicals can occur under aerobic or anaerobic conditions, i.e., with or without oxygen. Under aerobic oxidation, molecular oxygen serves as an electron acceptor and is incorporated into the structure of the organic chemical, with water as a by-product. In anaerobic degradation, other molecules, such as carbon dioxide, nitrate, and sulfate, are used as the electron acceptor. Anaerobic reaction rates are usually much slower than aerobic reaction rates. The introduction of oxygen into an anaerobic soil system can stimulate biodegradation. However, since about 3 to 4 mg/liter of oxygen is required to degrade 1 mg/liter of a medium-length hydrocarbon compound, the amount of oxygen required to stimulate an anaerobic system is rather large.

Research has found a number of "rules of thumb" that are useful for estimating which compounds will be biodegraded. These rules focus on the structure or functional group of a particular compound:

- Water-soluble chemicals are usually degraded faster than less soluble chemicals.
- The rate of oxidation of straight-chain aliphatic hydrocarbons is correlated to chain length; in general, short chains are not as quickly degraded as long chains.
- Unsaturated aliphatic organics have faster biodegradation rates than corresponding saturated aliphatic organics.
- As the number of chlorine atoms within the molecule increases, the biodegradation rate decreases.
- Gaseous n-alkanes (C1 to C4) are biodegradable, but are usually utilized by a narrow range of specialized hydrocarbon degraders.
- N-alkanes, n-alkyl aromatics, and aromatic hydrocarbons in the C5 to C9 range are biodegradable, but in most environments, volatilization competes very effectively with biodegradation as a fate process.
- N-alkanes, n-alkyl aromatics, and aromatic compounds in the C10 to C22 range are usually readily biodegradable.
- The n-alkanes, n-alkyl aromatic, and aromatic compounds above C22 have very low water solubilities, which results in slow rates of microbial degradation.

Based upon these rules of thumb, it can be assumed that the aromatic and aliphatic compounds with less than 22 carbons in JP-4, diesel fuel, fuel oil, and lubricating oils will biodegrade readily if spilled on the soils of Selfridge ANGB. The aliphatic and aromatic compounds with greater than 22 carbon carbons biodegrade at a considerably slower rate.

Table 4-15 lists biodegradation rate constants for selected organic chemicals of interest to Selfridge ANGB for natural soil-groundwater systems based on field observations. Alkanes (C_6 to C_{10}) have been observed to have a biodegradation half-life of less than 4 days, benzene a half-life between 48 and 110 days, toluene a half-life of 37 to 39 days, xylenes a half-life of 11 to 37 days, and naphthalene a half-life of 110 days in natural soil-groundwater systems. Chlorinated solvents such as tetrachloroethlene, trichloroethlene, and trichloroethane have 300-day half-lives. Pyrene has been observed to have a half-life of 210 to 1,900 days, benzo(k)fluoranthene a half-life of 910 to 1,400 days, and benzo(g,h,i)perylene a half-life of 590 to 650 days in laboratory experiments.

Given the discussion presented above, it is reasonable to conclude that natural biodegradation is active at the IRP sites. This activity would be greatest in the near-surface part of the vadose zone at locations with elevated concentrations of organic contamination. Residence times of 1 to 2 months in the vadose zone would be sufficient to reduce benzene, toluene, and xylenes concentrations by half. Biodegradation may also be significant for other short-chain, low-carbon compounds at the Selfridge ANGB sites. The rates of biodegradation would be considerably slower the deeper the chemical constituents infiltrate into the reduced silty, clayey soils due to a lack of nutrients and oxygen. In addition, chlorinated compounds, solvents, and compounds with greater than 22 carbons will tend to persist and remain a contamination problem.

4.2.3.4 Inorganic Chemical Reactions in Soil

In the first few feet of soil, inorganic chemicals can be temporarily tied to soil by adsorption-desorption surface reactions with soil organic matter. Below this region the amount of organic matter in soils decreases, and soil minerals exert significant control over inorganic chemicals via adsorption and fixation. The increase of an inorganic chemical concentration in subsurface water may cause fixation reactions to occur when the amount of dissolved inorganic chemical exceeds its solubility. These include new mineral precipitation, chemisorption, solid-state diffusion into soil mineral lattice structures, and occlusion of the soil minerals. These reactions transform or fix the chemical in an unavailable or unleachable form.

Precipitation refers to the formation of an insoluble solid comprised of elements that were previously dissolved in water.

Table 4-15

Biodegradation and Disappearance Rates for Several Organic Chemicals, IRP Stage 2, Selfridge ANGB, MI

Organic Chemical	Biodegradation or Disappearance Rate
Acetophenone	4-day half-life
Alkanes (C6 to C10)	<4-day half-life
Benzene	110-day half-life
	68-day half-life
	100% in 434 days
Biphenyl	37-day half-life
Chlorobenzene	37-day half-life
Cresols	4-day half-life
Dichlorobenzenes	110-day half-life
Diphenyl ether	11-day half-life
Ethylbenzene	37-day half-life
Methylcresols	110-day half-life
Naphthalene	110-day half-life
Tetrachloroethene	300-day half-life
Toluene	37-day half-life
	39-day half-life
	100% in 80 days
Trichlorobenzenes	11-day half-life
1,1,1-Trichloroethane	300-day half-life
Trichloroethene	300-day half-life
m-Xylene	37-day half-life
	15-day half-life
	100% in <300 days
o-Xylene	11-day half-life
	32-day half-life
	100% in <300 days
p-Xylene	37-day half-life
	17-day half-life
	100% in <300 days

Adapted from Dragun, 1988.

It is usually a reduction reaction in soils. Chemisorption is the formation of a covalent bond between an adsorbed element and a mineral surface, which results in element immobilization. Solid-state diffusion refers to the irreversible penetration of an element into the pore spaces of a mineral structure. Occlusion refers to the binding of a chemical species by adsorption by a soil mineral.

Of these four reactions, precipitation is by far the most important. The other four are not considered to be extensively occurring (Dragun, 1988). When an element will precipitate is determined by its solubility, the redox potential of the soil (Eh), and the pH of the soil water. The general redox potential of the soils at Selfridge ANGB can be determined by examining the soil color. The reddish-gray brown clays of the vadose (fill) zone are indicative of oxidized minerals of iron. The dull gray saturated lacustrine clays are indicative of reduced minerals of manganese and iron.

In general, in the oxidized region of the soil organic matter and mineral constituents interact with CO_2- and O_2-rich recharge water from the surface and actively leach and transport dissolved species to the reduced saturated zone, resulting in precipitation of minerals and fixation. Thus, if metals-rich waste was buried in the Selfridge ANGB landfills, it can be anticipated that natural leaching reactions will move these metals to the reduced zone and tend to precipitate them.

If the leached metals reach the reduction zone and it contains contaminated landfill leachate containing anions such as $Cl^{(-)}$, $CO_3^{(2-)}$, $HCO_3^{(-)}$, CO_2, $SO_4^{(2-)}$, $S^{(-2)}$, $HS^{(-)}$, $HSO_4^{(-)}$ and less commonly NH_3, $NO_3^{(-)}$, and $F^{(-)}$, fixation will not occur, and the metals will be remobilized in the aqueous phase by hydrolysis and complexation (chelation). Chelation reactions can be enhanced by dissolved organic contaminants that can form organo-metallic complexes. Once remobilized in the aqueous phase, metal migration velocities can be calculated by the retardation equation (6). These calculations are made in the Extent of Contamination subsections for each site.

Of the 16 inorganic constituents regulated by drinking water standards, 9 have more than one possible oxidation state in groundwater (As, Cr, Fe, Hg, Mn, Se, U, N, and S) and participate in reduction, hydrolysis, and chelation reactions. Four other inorganic constituents are strongly influenced (Ag, Cu, Cd, and Zn) by these reactions. Ions $Cl^{(-)}$, $F^{(-)}$, and $Ba^{(2+)}$ are not participants in redox conditions, but $Cl^{(-)}$ and $F^{(-)}$ participate in hydrolysis and chelation. It can be anticipated that in the landfill leachates of SWLF, NWLF, and TCLF at Selfridge ANGB, these inorganic constituents will be transported and added to the groundwater. As they move away from the landfill in the groundwater, the clay soil will begin to remove these constituents by fixation reactions.

4.2.3.5 Summation of Removal of Contaminants by Natural Processes

Table 4-16 summarizes the effectiveness of the different natural processes in removing chemical constituents from the soil. In general, a large fraction (greater than 80 percent) of the organic compounds that have simpler structures and carbon numbers less than 22 in hydrocarbon fuels and oils and paints will be removed from the soils of Selfridge ANGB by natural processes of diffusion, volatilization, and biodegradation. The remaining fraction of the hydrocarbon fuels and oils and paints are much more resistant to these natural processes. However, the aromatic portions of these heavier fractions of hydrocarbon fuels and oil and paints may be slightly removed by oxidation. Chlorinated solvents and lacquers are volatile and are removed from the soil by volatilization and diffusion. They also are altered by hydrolysis, substitution, elimination, and reduction in soil and tend to be resistant to biodegradation. Pesticides are almost unaffected by natural processes. They do not biodegrade, volatilize, or react with the soil. The inorganic portions of landfill leachate are very much affected by chemical reactions with the soil and can be alternatively fixated or mobilized by these reactions. The organic fraction of landfill leachate is highly variable and will be removed by natural processes, depending on its composition.

4.2.4 Contaminants of Concern

4.2.4.1 Identification of Contaminants of Concern

Approximately 70 chemicals were identified in the surface water, groundwater, and soil at the 8 IRP sites at Selfridge ANGB. At sites where a large number of chemicals have been identified, it is impractical to evaluate the potential risks posed by each chemical. Therefore, indicator chemicals are chosen to best represent the overall risks to human health posed by all contaminants present at the site. These indicator chemicals are selected based on their relative concentration, distribution, ability to migrate, and toxicological properties. The indicator chemicals were selected for each site using the guidelines outlined in the Superfund Public Health Evaluation Manual (SPHEM) (U.S. EPA, 1986).

Prior to the selection of indicator chemicals, valid inorganic data were compared with available background concentrations data. Inorganic chemicals that were detected in soil, groundwater, and surface water at or below background levels were not considered contaminants and were eliminated. All organic compounds detected were considered contaminants.

The chemicals remaining after the background screening were separated into two groups, based on whether or not an oral toxicity constant was available in the SPHEM. Indicator chemicals

Table 4-16

Summary of Removal of Contaminants by Natural Processes, IRP Stage 2, Selfridge ANGB, MI

Waste or Chemical	Emissions Rate (kg/hr)*			Chemical Reaction				Biodegradation
	On Concrete	On Soil	20-cm Soil Cover	Reduction	Hydrolysis	Sub & Elim	Oxidation	(Half-Life)
Toluene	40.3	0.41	0.004					
Octane	19.4	0.20	0.0016					
Fuels & oils <22 carbons				Unknown	No	No	No	4-110 days
Fuels & oils >22 carbons		As above		Unknown	No	No	No	210->1,900 days
Aromatics				Unknown	No	No	Yes	11->1,900 days
Chlorinated solvents		As below		Unknown	Yes	Yes	No	300-500 days
Chlorobenzene	24.0	0.28	0.0025					
Pesticides	Negligible	Negligible	Negligible	No	No	No	No	None
<u>Landfill Leachate</u>								
Inorganic	None	None	None	Immobilize***	Mobilize**	Mobilize	Mobilize	None
Organic	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable

* Emissions rate based on temperature of 25°C, wind speed of 447 cm/sec, and area of 25 square meters.
** Chemical reaction mobilizes inorganic fraction in landfill leachate.
*** Chemical reaction immobilizes inorganic fraction in landfill leachate.
As above – Emissions values for octane and toluene are representative for fuels, oils, and aromatics.
As below – Emissions values for chlorobenzene representative of chlorinated solvents.

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were selected from both groups as described in the following. Although inhalation toxicity constants are also available for some of the chemicals, there are no air data available for specific contaminants.

Indicator scores were calculated for the chemicals with oral toxicity constants, based on both the maximum and average concentrations reported in water, using guidelines reported in the SPHEM. These chemicals were then ranked according to their indicator scores. Those chemicals with a lower numerical ranking index and those that could be represented by more toxic chemicals with similar physical and chemical properties were eliminated from further consideration.

The chemicals without toxicity constants were evaluated with regard to their relative concentration, distribution, and toxicological properties. Those that were detected on site at low concentrations or at concentrations that had a low toxic potential, or those that could be represented by similar, more toxic compounds, were eliminated.

The indicator chemicals tentatively selected from both groups were then compared for each site, and a final selection of indicator chemicals was made based on the total number of contaminants (on the site).

4.2.4.2 Contaminant-Specific Characteristics and Behaviors

The physicochemical properties of the contaminants of concern identified for the individual IRP sites are summarized in Table 4-17. A brief explanation of each physicochemical property is as follows:

- Aqueous Solubility -- The degree to which a compound in its pure state will dissolve in water. The higher the aqueous solubility, the higher the concentration of the compound in a water-based solution that is saturated with that compound.

- Specific Gravity -- The ratio of the density of the compound in its pure form to the density of water. Compounds having a specific gravity less than 1.0 will tend to float on water when they occur as a pure product. Compounds having a specific gravity greater than 1.0 in pure product form will tend to sink through water until they reach an impervious or low-permeability layer.

- Viscosity -- The internal fluid resistance of a substance, caused by molecular attraction, that makes it resist a tendency to flow in environmental media.

- Vapor Pressure -- The pressure exerted by a vapor in equilibrium with a liquid. A liquid is volatile (high vapor pressure) or non-volatile (low vapor pressure).

Table 4-17

Summary of Physicochemical Properties of Indicator Chemicals, IRP Stage 2, Selfridge ANGB, MI

Chemical	Aqueous Solubility (mg/L)	Specific Gravity	Viscosity (centipoise)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm/cu m/mole)	Log Octanol/ Water Partition Coefficient (dimensionless)
Acetone	1×10^6	0.7972	NA	270	2.06×10^{-5}	-0.24
Ammonia	5.3×10^5	0.77	NA	7.6×10^3	3.21×10^{-4}	0.0
Barium	Insoluble	3.5	NA	10	NA	NA
Benzene	1,780	0.8786	0.652	76	5.5×10^{-3}	2.13
Beryllium	Insoluble	1.85	NA	NA	NA	NA
Cadmium	Insoluble	8.642	NA	1.0	NA	NA
Carbon disulfide	2,940	1.261	NA	360	1.23×10^{-2}	2.00
Chlorinated Benzenes						
Chlorobenzene	466	1.105	NA	11.7	3.72×10^{-3}	2.84
1,2-Dichlorobenzene	145	1.307	NA	1.5	1.94×10^{-3}	3.38
1,3-Dichlorobenzene	123	1.289	NA	2.28	2.63×10^{-3}	3.38
1,4-Dichlorobenzene	79	1.45	NA	10	2.72×10^{-3}	3.39
Chloroform	8,000	1.485	NA	160	NA	NA
1,1-Dichloroethane	5.5×10^3	1.174	NA	1.82×10^2	4.31×10^{-3}	1.79
1,2-Dichloroethane	8.52×10^3	1.2554	NA	6.4×10^1	9.78×10^{-4}	1.48
1,2-Dichloroethene	Slight	1.257	NA	265	NA	NA
Dichlorodifluoromethane	NA	1.48	NA	1.6	NA	NA
Ethylbenzene	140	0.867	0.691	7	8.7×10^{-3}	3.15
Methyl ethyl ketone	353,000	0.006	0.49	71.2	NA	NA
4-Methyl-2-pentanone	19,000	0.8017	NA	6.0	NA	NA
Nickel	Insoluble	8.908	1.0	0	NA	NA
Phenolics						
2,4-Dimethylphenol	Slight	1.076	NA	NA	NA	NA
Phenol	9.3×10^4	1.07	NA	3.41×10^{-1}	4.54×10^{-7}	1.46
Pentachlorophenol	1.4×10^1	1.987	NA	1.1×10^{-4}	2.75×10^{-6}	5.0

HRS Persistance Rating
1: Minimal Persistance
2: Moderate Persistance
3: Significant Persistance

NA = Not Available

Sources: Lee, C.K. (unpublished)
Vercheusen, 1983
Sax, 1984
Sittig, 1985
Hawley, G.G. 1981
Merck Index, 1983

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Table 4-17
(continued)

Chemical	Molecular Weight (g/mole)	Melting Point (°C)	Boiling Point (°C)	Vapor Density (Air=1)	Persistance
Acetone	58	-95.35	56.2	2.00	1
Ammonia	17	-77.7	-33.5	0.6	1
Barium	137	725	1,640	NA	3
Benzene	78.11	5.5	80.1	2.77	1
Beryllium	9.01	1,280	2,970	NA	3
Cadmium	112.4	320.9	767	NA	3
Carbon disulfide	76	-110.8	46.5	2.64	1
Chlorinated Benzenes					
Chlorobenzene	113	-4.5	131.6	3.88	NA
1,2-Dichlorobenzene	147.0	-17.5	181.5	5.05	2
1,3-Dichlorobenzene	147.0	53	173.4	5.07	2
1,4-Dichlorobenzene	147.0	53.1	174	5.08	3
Chloroform	119	-64	-62	4.12	NA
1,1-Dichloroethane	99	-97.4	58	3.42	NA
1,2-Dichloroethane	99	-35.4	83.5	NA	NA
1,2-Dichloroethene	90	NA	48	NA	NA
Dichlorodifluoromethane	102.9	-135	8.9	3.56	NA
Ethylbenzene	106.17	-94.97	136.2	3.66	1
Methyl ethyl ketone	72.1	-86.4	79.6	2.41	NA
4-Methyl-2-pentanone	100	-82.5	117.5	3.45	NA
Nickel	59	1,455	2,730	NA	3
Phenolics					
2,4-Dimethylphenol	122.2	26	211.5	NA	NA
Phenol	94	40.6	182	8.24	NA
Pentachlorophenol	266	190	310	9.20	NA

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Vercheusen, 1983
Sax, 1984
Sittig, 1985
Hawley, G.G. 1981
Merck Index, 1983

Table 4-17
(continued)

Chemical	Aqueous Solubility (mg/L)	Specific Gravity	Viscosity (centipoise)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm/cu m/mole)	Log Octanol/ Water Partition Coefficient (dimensionless)
Phthalates						
Diethyl phthalate	8.96×10^{2}	1.120	NA	3.5×10^{-3}	1.14×10^{-6}	2.50
Di-n-butyl phthalate	1,300	NA	NA	1.00×10^{-5}	2.28×10^{-7}	5.60
Butyl benzyl phthalate	NA	1.117	NA	NA	NA	NA
Bis(2-ethylhexyl) phthalate	NA	NA	NA	NA	NA	NA
PAHs						
Anthracene	4.5×10^{-2}	1.25	NA	1.95×10^{-4}	1.02×10^{-3}	4.45
Chrysene	0.02	1.274	NA	1.0×10^{-11}	NA	5.61
Benzo(k)fluoranthene	4.0×10^{-3}	NA	NA	5.1×10^{-7}	3.94×10^{-5}	6.06
Pyrene	1.32×10^{-1}	1.271	NA	2.5×10^{-6}	5.04×10^{-6}	4.88
Benzo(b)fluoranthene	NA	NA	NA	1.0×10^{-11}	NA	6.57
Fluoranthene	2.06×10^{-1}	NA	NA	5.0×10^{-6}	6.46×10^{-6}	4.90
Indeno(1,2,3-c,d)pyrene	NA	NA	NA	1.0×10^{-10}	NA	7.66
Phenanthrene	1.00	1.179	NA	6.8×10^{-4}	1.59×10^{-4}	4.46
Benzo(a)pyrene	0.0038	NA	NA	5×10^{-9}	1×10^{-5}	6.04
Benzo(a)anthracene	0.01	NA	NA	5×10^{-9}	NA	5.61
Benzo(g,h,i)perylene	7.0×10^{-4}	NA	NA	1.03×10^{-10}	5.34×10^{-8}	6.51
Dibenzo(a,h)anthracene	0.0005	NA	NA	1.0×10^{-10}	NA	5.97
1,1,2,2-Tetrachloroethane	2,900	1.588	NA	5.0	3.81×10^{-4}	2.39
Tetrachloroethene	1,100	1.46	0.566	60	1.17×10^{-4}	2.29
Toluene	470	0.867	0.590	22	5.93×10^{-3}	2.69
1,1,1-Trichloroethane	4,400	1.35	1.2	100	4.92×10^{-3}	2.17
Trichloroethene	1,100	1.46	0.566	60	1.17×10^{-4}	2.29
Trichlorofluoromethane	Insoluble	1.494	NA	690	NA	NA
Vinyl chloride	Slight	0.912	NA	2,600	NA	NA
Xylenes	185	0.87	NA	6	NA	3.10

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Vercheusen, 1983
Sax, 1984
Sittig, 1985
Hawley, G.G., 1981
Merck Index, 1983

Table 4-17
(Continued)

Chemical	Molecular Weight (g/mole)	Melting Point (°C)	Boiling Point (°C)	Vapor Density (Air=1)	Persistance
<u>Phthalates</u>					
Diethyl phthalate	222	-40.5	298	7.66	NA
Di-n-butyl phthalate	278	NA	NA	NA	NA
Butyl benzyl phthalate	NA	NA	NA	NA	NA
Bis(2-ethylhexyl) phthalate	391	NA	NA	NA	NA
<u>PAHs</u>					
Anthracene	178	217	340	6.15	2
Chrysene	228.3	259	488	NA	2
Benzo(k)fluoranthene	252	NA	NA	NA	2
Pyrene	202	156	404	NA	2
Benzo(b)fluoranthene	252.3	NA	NA	NA	2
Fluoranthene	202	107	250	NA	2
Indeno(1,2,3-c,d)pyrene	276.3	160-163	536	NA	2
Phenanthrene	178	100	339	6.14	2
Benzo(a)pyrene	252.3	179	311	NA	2
Benzo(a)anthracene	228.3	162	435	NA	2
Benzo(g,h,i)perylene	276	NA	NA	NA	2
Dibenzo(a,h)anthracene	278.4	266	524	NA	2
1,1,2,2-Tetrachloroethane	168	-43	146.4	5.79	2
Tetrachloroethene	165.83	-22.7	121.4	5.83	2
Toluene	92.1	-95.1	110.8	3.14	1
1,1,1-Trichloroethane	133.41	-32.5	74.1	4.63	2
Trichloroethene	131.5	-87	86.7	4.54	2
Trichlorofluoromethane	137	-111	23.7	5.04	NA
Vinyl chloride	62.5	-160	-13.9	2.15	NA
Xylenes	106.17	-35	140.0	3.7	NA

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NA = Not Available

Sources: Lee, C.K. (unpublished)
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- Henry's Law Constant -- An expression of the distribution of the chemical between air and water at equilibrium. Usually defined as the ratio of the partial pressure of the compound in air, measured in the atmosphere, to the mole fraction of the compound in a water solution. The larger the Henry's Law Constant, the greater the susceptibility of the compound to air stripping for removal from water.

- Molecular Weight -- The weight of a molecule of a chemical expressed in atomic mass units. Compounds with large molecular weights tend to be less susceptible to biodegradation.

- Melting Point -- The temperature at which a pure liquid normally freezes and the corresponding solid substance melts.

- Boiling Point -- The temperature at which the vapor pressure of a liquid becomes equal to the atmospheric pressure and at which the liquid passes into the vapor phase.

- Vapor Density -- The weight of a given volume of a chemical relative to the weight of the same volume of air. A vapor with a density close to that of air will be miscible with air; a vapor with a density much less or much greater than air will tend to stratify out in an atmospheric column.

- Log Octanol/Water Partition Coefficient -- This is an indicator of a compound's affinity for solvent or aqueous phases. Compounds with high coefficients tend to partition to the solvent phase and have the potential to accumulate in fatty tissue.

- Persistence -- Persistence of a compound in an environment is based on leaching, volatilization, photodecomposition, chemical degradation, and biological transformation.

Each of these properties controls, to some extent, how a compound will interact with and migrate in different media. These properties, therefore, affect both the environmental fate and the potential remediation of a compound. The potential environmental fates of the contaminants of concern based on physicochemical and biological interactions are summarized as follows.

Acetone

Acetone is not expected to be highly persistent in the environment. Although it has a high vapor pressure (190 mm Hg at 20°C), it would probably undergo only limited volatilization from water due to its high water solubility. Based on its low

log octanol/water partition coefficient (-0.24), sorption to sediments would be expected to be limited. Biodegradation is likely to be an important process for removing acetone from the environment (Clement Associates, Inc., 1985).

Ammonia

Ammonia is a colorless gas used primarily in the manufacture of fertilizer. As a fertilizer, it is applied to soil either by the injection of the anhydrous gas or as an aqueous solution (Wands, 1981). Ammonia is strongly adsorbed to soil and sediments. High concentrations may occur in oxidizing sediments. Anoxic conditions tend to reduce the adsorptive capacity of sediments (Environment Canada, 1981). Biodegradation is likely to be the most important removal process in soil. Microorganisms readily oxidize ammonia to nitrate during the nitrification process (Connell and Miller, 1984).

Ammonia exhibits high solubility in water (90 g/100 mL at 0°C) (Wands, 1981). In oxygenated water it is readily converted to nitrate by aquatic nitrifying bacteria. This process is known to be sensitive to variations of pH and temperature (Environment Canada, 1981).

Owing to its gaseous nature, the atmosphere represents an important release pathway. In the atmosphere, ammonia is removed primarily through combination with sulfate ions and washout. Such processes result in deposition onto soil and water. Some atmospheric ammonium ions are oxidized to oxides of nitrogen and nitrate ions. In this manner ammonia contributes significantly to the total acidity of rainfall (Environment Canada, 1981).

Barium

Barium metal is stable in dry air but is rapidly oxidized by moist air or water. Although many salts are soluble in water, concentrations in natural surface waters or groundwater are relatively low, due largely to the formation of barium sulfate. Other processes that remove barium from solution include the formation of insoluble barium carbonate and sorption. The solubility of barium may be increased by the presence of chloride. Barium may be transported in the atmosphere as particulates. Bioaccumulation is not an important fate process (Clement Associates, Inc., 1985).

Benzene

Benzene is a moderately volatile, water soluble, organic chemical with low chemical reactivity due to its stable ring structure. The most significant fate process for benzene is volatilization from water, soil, or air. Within the air medium,

the dominant fate process is oxidation by hydroxyl radicals. Biodegradation by microbial species may be important in some media, but it is not universally important. Although no values for half-life are available for volatilization of benzene from the soil, this process proceeds rapidly. Some portion of a released amount remains within the initial medium as an ambient level until either biodegradation or migration occurs.

Benzo(a)pyrene and Other PAHs

Benzo(a)pyrene and other polynuclear aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene) are developed from hydrocarbons combustion processes. They are also present in elevated concentrations (300 to 500 ppm) in coal tar, creosote, waste engine oil, and No. 6 fuel oil (Stockman and Dime, 1986).

Very little information on specific PAHs is available. The environmental fate and transport of these compounds are largely inferred from data on benzo(a)pyrene and mixtures of PAHs. The relatively high octanol/water partition coefficients of PAHs indicate that they should be strongly adsorbed onto suspended particulate matter, especially particulates high in organic content. The available information suggests that these compounds can accumulate in the sediment and biota portions of the aquatic environment and that adsorption is probably the dominant aquatic transport process. Atmospheric transport of PAHs is also possible. This generally occurs by adsorption onto airborne particulate matter, but some PAHs with relatively low molecular weights are volatile. Regardless of the method of atmospheric transport, PAHs are returned to aquatic and terrestrial systems by atmospheric fallout of precipitation. They can also reach groundwater or surface waters by leaching from contaminated soils. PAHs are relatively insoluble in water, but the dissolved portion may undergo rapid, direct photolysis. Oxidation by chlorine and ozone may be an important fate process when those oxidants are available in sufficient quantities.

Although PAHs are rapidly bioaccumulated, they are also quickly metabolized and are eliminated from most organisms (shellfish are a known exception). Bioaccumulation, especially in vertebrate organisms, is usually short term, so it is not considered an important fate process in multicellular organisms. Biodegradation and biotransformation are probably the ultimate fate processes for PAHs. The available data suggest that the PAHs with high molecular weights are degraded slowly by microbes and are readily metabolized by multicellular organisms. Microbes appear to degrade PAHs much more completely than mammals. Biodegradation probably occurs more slowly in aquatic systems than in soil, and it may be much more important in systems that are chronically affected by PAHs contamination (Clement Associates, Inc., 1985).

Beryllium

Beryllium is a naturally occurring metal, having an average crustal abundance of 2.5 ppm (Weast, 1977). In most soil types beryllium is expected to displace divalent cations, resulting in its adsorption to soil (Fishbein, 1981). Exhibiting geochemistry similar to that of aluminum, it is suggested that beryllium will adsorb to clay particles at low soil pH and form various insoluble complexes at higher soil pH (Callahan, et al., 1979).

In aquatic environments soluble beryllium salts are hydrolyzed to form insoluble beryllium hydroxide, $Be(OH)_2$ (Cotton and Wilkinson, 1972). The formation of hydrated complexes may increase the solubility of beryllium, particularly at higher pH. In most natural water systems, however, this is unlikey since beryllium is present as a particulate rather than dissolved species (Clement Associates, Inc., 1985).

The majority of beryllium in the atmosphere results from coal combustion. Atmospheric beryllium occurs mostly as the insoluble oxide (EPA, 1986). Beryllium oxide from stack emissions is typically found on particles smaller than 1 micron (Gladney and Owens, 1976). Wet and dry deposition represent the dominant removal processes for atmospheric beryllium (EPA, 1986).

No evidence of volatilization of beryllium from water or soil into the atmosphere was found. Evidence regarding the potential for aquatic or soil biotransformation of beryllium or its compounds also was not found (ATSDR, 1987).

Cadmium

Natural sources of cadmium in the environment resulting from the weathering of minerals are relatively small. Most of the environmental releases come from anthropogenic sources, including fossil-fuel combustion, emissions from smelting operations, the application of phosphate fertilizers, and the disposal of metal-containing products (ATSDR, 1987a).

Atmospheric cadmium exists primarily as particulate matter and can be transported for considerable distances. Removal can occur via dry or wet deposition. Cadmium may be present in soil as cadmium compounds, as the divalent cation dissolved in soil water, or sorbed to inorganic or organic matter via cation exchange. Low soil pH favors cation release and cadmium uptake by plants. The proportion of cadmium present as insoluble cadmium sulfide is minimized in topsoil by the presence of oxygen. Cadmium bioaccumulation by feed crops can lead to increased concentrations in beef and poultry (ASTDR, 1987a).

Cadmium concentrations in groundwater tend to be low due to sorption to inorganic or organic substances and precipitation

as cadmium sulfide or cadmium carbonate. In surface waters, cadmium is relatively mobile compared to other heavy metals. In natural waters, cadmium may be present as the simple hydrated ion, as cadmium-inorganic complexes, or as cadmium-organic complexes. Because cadmium only exists in water in the divalent oxidation state, the redox potential of the water has little effect on its chemical speciation. However, under reducing conditions such as those present in sediments, cadmium may precipitate as cadmium sulfide. At high pH cadmium may also be removed from solution by the formation of the hydroxide or carbonate. The concentration of soluble cadmium in surface water is, therefore, inversely proportional to the pH, as well as to organic matter with which it tends to complex. Sorption is likely to be a more important process in removing cadmium from solution than precipitation (Versar, 1979).

Cadmium strongly bioaccumulates in aquatic organisms through both food and water. Bioconcentration factors of several hundred to several thousand have been reported in freshwater and marine plants, fish, and invertebrates, with the highest concentrations reported in vertebrates. Biomethylation or reduction of cadmium by microorganisms is not known to occur (Versar, 1979).

Carbon Disulfide

Carbon disulfide is produced in the petroleum- and coal tar-refining industries. Its main commercial uses include manufacturing rayon, rubber, solvents, and pesticides. Information regarding its potential environmental fate is lacking. It is soluble in water (0.294 percent at 20°C) and has been detected in drinking water supplies (NAS, 1977). It is moderately volatile (vapor pressure of 400 mm Hg at 20°C (Merck Co., 1968)) and would probably tend to volatilize from surface waters or surface soils. Based on its log octanol/water partition coefficient of 2.00, sorption to sediments or bioaccumulation would not be expected to be important fate processes.

Chlorobenzene

Chlorobenzene has widespread use as an industrial solvent. Because it is volatile, most environmental release is to the atmosphere. The disposal of waste solvent has led to its release to water and soil. There are no natural sources of chlorobenzene.

Chlorobenzene has a relatively low solubility in water (488 mg/L at 25°C) and a low vapor pressure (approximately 9 to 12 mg Hg at 20°C). Nonetheless, chlorobenzene is expected to volatilize relatively rapidly from surface water. Several sources have indicated that its half-life in a water column 1 meter deep would be approximately 10 hours, assuming nonturbulent conditions. However, based on its log octanol/water partition coefficient (approximately 2.8), chlorobenzene may potentially undergo substantial sorption to sedimentary organic

material, thereby substantially decreasing its rate of volatilization. Experimental data suggest that chlorobenzene is degraded slowly in the atmosphere by photooxidation.

Laboratory studies indicate that chlorobenzene is resistant to biodegradation in aquatic systems. Limited evidence suggests that biodegradation in soil may be enhanced if another more easily degraded aromatic hydrocarbons source is present. Chlorobenzene has been shown to substantially bioaccumulate in aquatic organisms including algae, invertebrates, and fish.

Hydroxylation appears to be the main detoxification mechanism in aquatic animal species (Versar, 1979).

Chloroform

Chloroform is a colorless organic liquid used primarily in the United States in the production of fluorocarbon-22 (ATSDR, 1987). Chloroform exhibits a relatively high vapor pressure (159 mm Hg at 20°C), which suggests that it will readily volatize from dry soil (Boublik, et al., 1984). In moist soil, evaporation is also expected since chloroform does not adsorb to soil and volatilizes rapidly from water (ATSDR, 1987). Chloroform has been found to be strongly adsorbed to peat moss (Dilling, et al., 1975).

Volatilization is the dominant removal process for chloroform in natural water systems (ATSDR, 1987). Measured K_{OC} values in soil range from 0 to 40, suggesting that adsorption to suspended solids and sediments in water is likely to be insignificant (Hutzler, et al., 1983). Data on the biodegradation of chloroform in natural water systems are conflicting. Some studies have shown little or no degradation under aerobic conditions for up to 25 weeks (Bouwer, et al., 1981a; Kawasaki, 1980; Heukelekian and Rand, 1955). Others have reported substantial degradation following shorter intervals of time (<28 days) (Tabak, et al., 1981; Bouwer, et al., 1981b, Flathman and Dahlgran, 1982). "Slow" degradation under anaerobic conditions has been reported (Bouwer and McCarty, 1983). Chloroform has been shown not to undergo significant bioconcentration in aquatic organisms (Barrows, et al., 1980; Anderson and Lusty, 1980).

Atmospheric chloroform is expected to exist entirely in the vapor state (Boublik, et al., 1984; Eisenreich, et al., 1981). Due to a low partition coefficient between air and water (H = 0.125), it is expected that a significant amount will be removed from the atmosphere by wet deposition (Nicholson, et al., 1984). Chloroform removed by wet deposition is likely to reenter the atmosphere by volatilization (ATSDR, 1987). Reaction with hydroxyl radicals is the primary removal process of atmospheric chloroform (Clement Associates, Inc., 1985). The half-life of chloroform in a typical atmosphere has been estimated

to be 70 to 79 days (Atkinson, 1985). Phosgene and chlorine oxide radicals are known to be the primary reaction products. Stratospheric chloroform is known to undergo photodissociation via interaction with ultraviolet light (Clement Associates, Inc., 1985).

Dichlorobenzenes

Dichlorobenzenes are released to the environment through use as insecticides and industrial solvents. There are three dichlorobenzene isomers, ortho- (1,2-), meta- (1,3-), and para- (1,4-). Relatively high log octanol/water and sediment/water partition coefficients indicate that adsorption to soils and sediments may be a major fate process for dichlorobenzenes discharged into aquatic media. Since dichlorobenzenes are only sparingly soluble in water compared with other organic compounds (79 to 145 mg/L), neither transport within water nor transport into water are expected to be a major environmental fate process. A moderate potential for bioaccumulation is indicated. Volatilization is likely to be a major environmental process for dichlorobenzenes in water. Hydrolysis and photolysis in water are negligible. The reaction of dichlorobenzenes with hydroxyl radicals in the atmosphere or in water is possible.

The rate of biodegradation of dichlorobenzenes in the environment may be sufficiently high to suggest that biodegradation is a major fate process for these chemicals in water. In one set of experiments measuring degradation, a static culture using acclimated microbial populations showed that, within 7 days, the 1,2- and 1,3-dichlorobenzenes were 29 to 35 percent degraded, respectively (Harris, et al., 1981).

Dichlorodifluoromethane (Freon 12)

Dichlorodifluoromethane is a relatively inert liquid used primarily as a refrigerant. It is very stable and persistent in the environment (U.S. EPA, 1980). Because of its high vapor pressure (approximately 4,300 mm Hg at 20°C) and low water solubility (280 mg/L at 25°C, releases to surface water or surface soils would be expected to result in rapid volatilization to the atmosphere (Callahan, et al., 1979).

Dichlorodifluoromethane is stable in the troposphere, being highly resistant to attck by free hydroxyl radicals. Estimates of tropospheric residence time range from 10 to over 40 years, (U.S. EPA, 1980). Most of the tropospheric dichlorodifluoromethane is expected to diffuse to the stratosphere. Small amounts may be deposited on soils and surface waters through wet deposition. In the stratosphere, the compound undergoes photodissociation as a result of the absorption of short-wavelength ultraviolet light. It is currently theorized that the chlorine atoms that are released by photodissociation may act

as catalysts in the destruction of the stratospheric ozone layer. Photodissociation is the main mechanism that determines the environmental fate of dichlorodifluoromethane (Callahan, et al., 1979).

Hydrolysis of dichlorodifluoromethane in aquatic systems is expected to be negligible when compared with the rate of volatilization. The log of its octanol/water partition coefficient, 2.16, suggests that some sorption to sediments may occur; however, no data are available to support this possibility. Similarly, based on the log K_{ow}, which indicates that the compound is lipophilic, bioaccumulation may occur under conditions of constant exposure. However, evidence has been presented that it does not undergo significant bioaccumulation (Howard, et al., 1975). There was no information available concerning the biodegradability of dichlorodifluoromethane (Callahan, et al., 1979).

1,1-Dichloroethane

1,1-Dichloroethane is a commercially produced chemical with no known naturally occurring sources. Because of its relatively high vapor pressure (182 mm Hg at 20°C), volatilization is expected to be the main fate of 1,1-dichloroethane in surface soils. Laboratory studies have indicated that dichloroethanes are not readily biodegraded. Biodegradation in subsurface soils is likely to be insignificant. 1,1-Dichloroethane is expected to persist in subsurface soils and be removed mainly through leaching to groundwater, where it is predicted to have a long residence time. (Callahan, et al., 1979; U.S. EPA, 1980, 1984).

Volatilization is predicted to be the predominant fate of 1,1-dichloroethane in surface waters. Bases on information for chemically similar compounds, the sorption of 1,1-dichloroethane to sediments is not expected to be an important process; oxidation and hydrolysis also appear to be insignificant for 1,1-dichlorethane in surface water. Its low octanol/water partition coefficient (1.79) suggests that 1,1-dichloroethane would not bioaccumulate to a significant extent (Callahan, et al., 1979). Some absorption by fish and oysters has been reported (Fishbein, 1980). A bioconcentration factor of 6.6 has been estimated based on its log K_{ow} (Veith, et al., 1979).

Atmospheric dispersion is an important mechanism for the transport of 1,1-dichloroethane, at least on a local basis. However, it does not persist in the atmosphere. In the troposphere, 1,1-dichloroethane is rapidly attacked by free hydroxyl radicals.

The lifetime of 1,1-dichloroethane in the troposphere has been estimated to be approximately 1 month. Relatively small amounts are expected to reach the stratosphere, where attack by short

wavelength ultraviolet light would cause photodissociation. Acetyl chloride has been shown to be the main initial photolytic product. Wet precipitation may cause the reintroduction of 1,1-dichloroethane to surface water and soils (Callahan, et al., 1979).

1,2-Dichloroethane

In 1978 1,2-dichloroethane was the highest volume chlorinated organic compound produced in the United States (Perwak, 1982). It has a low octanol/water partition coefficient and is only slightly soluble in water. As a result, leaching through the soil is expected to be a major route of dispersal (Clement Associates, Inc., 1985). Volatilization is recognized as the dominant removal process from surface soils. Owing to low chemical reactivity, 1,2-dichloroethane is expected to persist in deep soils (Perwak, 1982).

Volatilization represents the dominant fate process for 1,2-dichloroethane in aquatic systems. As a result of a high vapor pressure (61 mm Hg at 20°C), evaporation to the atmosphere is expected to be quite rapid (Callahan, et al., 1979). Removal of 90 percent in 96 minutes from water at 25°C stirred at 200 rpm has been experimentally demonstrated (Dilling, et al., 1975). Based on a low octanol/water partition coefficient (1.48), 1,2-dichloroethane is not expected to bioaccumulate in aquatic systems. Metabolism by fish and oysters has been reported; however, this represents a minor fate process (Pearson and McConnell, 1975). Loss due to hydrolysis and oxidation are also recognized as being insignificant (Perwak, 1982).

The atmosphere represents the most important receiving environment for 1,2-dichloroethane. Atmospheric residence time is expected to be short due to rapid removal via reaction with hydroxyl radicals. The principal reaction products include monochloroacetyl chloride, chloroacetic acid, formyl chloride, phosgene, chlorine, and hydrogen (Perwak, 1982). Atmospheric half-life for reaction with hydroxyl radicals has been estimated at 1 to 4 months (U.S. EPA, 1975). Very little unreacted 1,2-dichloroethane is expected to reach the stratosphere where it will undergo dissociation by ultraviolet light. Acetyl chloride is thought to be an initial photodissociation product. (U.S. EPA, 1975). Dry impact, washout, and dry fallout of particles containing adsorbed 1,2-dichloroethane are known to contribute to atmospheric removal (Perwak, 1982).

Biodegradation of 1,2-dichloroethane in soil and water has been observed; however, degradation is known to be slow. (Perwak, 1982).

1,2-Dichloroethene

1,2-Dichloroethene occurs in cis- and trans-isomeric forms. The 1,2-dichloroethenes are synthetic chemicals with no known

natural sources. There are limited data concerning the environmental fates of the 1,2-dichloroethenes; however, their behavior can be predicted on the basis of information for chemically similar compounds. Because of their similar physical properties, the two isomers are expected to behave similarly in the environment (U.S. EPA, 1987).

Because of their high volatility (vapor pressures of 208 mm Hg (cis-) and 324 mm Hg (trans-) at 25°C), the 1,2-dichloroethenes are expected to rapidly volatilize from surface soils. Biodegradation in soil is expected to be a slow process (U.S. EPA, 1984a; 1984b). The 1,2-dichloroethenes are mobile in soils and are expected to leach into and migrate with groundwater, in which they are stable. The 1,2-dichloroethenes found in groundwater, particularly the cis- isomer, may be degradation products of trichloroethene, tetrachloroethene, and/or vinyl chloride (U.S. EPA, 1987).

The main fate of the 1,2-dichloroethenes in surface water appears to be volatilization. Photodissociation, hydrolysis, sorption, and oxidation are unlikely to be significant fate processes in surface water. The 1,2-dichloroethenes also are not expected to bioaccumulate in plants or animals.

Aerial transport may play a major role in their distribution. It is predicted that they would be transported to the troposphere where photooxidation is expected to rapidly degrade them to products such as formic acid, hydrochloric acid, and carbon monoxide. Their lifetime in the troposphere is estimated at less than 1 day. It is unlikely that the 1,2-dichloroethenes will be transported to the stratosphere (Versar, 1979).

Ethylbenzene

Ethylbenzene is released to the environment during the manufacture of cellulose acetate, styrene, and synthetic rubber (C.K. Lee, unpublished). Only limited data are available on the transport and fate of ethylbenzene. Volatilization is probably the major route of elimination from surface water. Subsequent atmospheric reactions, especially photooxidation, are responsible for its fate. However, its high log octanol/water partition coefficient suggests a significant amount of ethylbenzene may be adsorbed by organic material in sediment. Some soil bacteria are capable of using ethylbenzene as a source of carbon; however, the relative importance of this potential route of ethylbenzene elimination has not been determined (Clement Associates, Inc., 1985).

Methylene Chloride

Methylene chloride is a volatile organic solvent used primarily in aerosol products and as a paint remover (ATSDR, 1987). It is expected to be mobile in soil since it is not adsorbed to

any significant degree (Dilling, et al., 1975). Loss of methylene chloride on soil surfaces is due primarily to volatilization (U.S. EPA, 1984). Biodegradation is also expected to be a significant fate process; however, this is recognized as being slow in soil (Wilson, et al., 1983).

Volatilization represents the dominant removal process in aquatic systems (U.S. EPA, 1979). This is strongly influenced by prevailing wind and mixing conditions. Aerobic and anaerobic biodegradation are thought to contribute to aquatic removal. Breakdown products include methyl chloride as an intermediate and carbon dioxide ultimately (ATSDR, 1975).

Atmospheric releases are expected to disperse readily and to be transported over significant distances. Tropospheric accumulation is not considered important due to scavenging by hydroxyl radicals (U.S. EPA, 1985a). Carbon dioxide, carbon monoxide, and phosgene are the major breakdown species following reaction with hydroxyl radicals (Clement Associates, Inc., 1985). The lifetime of tropospheric methylene chloride under typical U.S. conditions has been estimated to range from minimum of a few months to a maximum of 1.4 years (Altshuller, 1980; Cox, et al., 1976; Crutzen and Fishman, 1977. Davis, et al., 1976; Singh, 1977; Singh, et al., 1979, 1983). Methylene chloride that reaches the stratosphere is known to degrade via photodissociation and reaction with chlorine radicals (HSDB, 1987). Due to its moderate water solubility, wet deposition may also contribute to atmospheric removal (ATSDR, 1987).

Methylene chloride exhibits a low octanol/water partition coefficient (1.25), suggesting that biocummulation and bioconcentration are not significant fate processes (Hansch and Leo, 1979).

Methyl Ethyl Ketone (2-Butanone)

2-Butanone is used as an industrial solvent, especially in the coatings industry. When spilled on land, 2-butanone will partially evaporate into the atmosphere and partially leach into the ground. The fate of residual contaminants in soil is unknown. When released into water, 2-butanone will evaporate into the atmosphere, with expected half-lives of 3 and 12 days in rivers and lakes, respectively. No information is available concerning its fate in groundwater, but biodegradability studies in anaerobic systems suggest that it may degrade slowly after a long acclimation period (1 week) (Chou, et al. 1979).

Adsorption to sediment will not be a significant loss process. When released into the atmosphere, 2-butanone will principally degrade by reaction with photochemically produced hydroxyl radicals. 2-Butanone is highly degradable in aerobic systems, using activated sludge, sewage seed, or inoculum from contaminated surface water (Dojlido, 1979; Price, et al., 1974; Bridie,

et al., 1979; Dose, et al., 1975; Heukelekian and Rand, 1955). Degradation is complete in about 5 to 10 days, with somewhat longer time being required in salt water. In 1979 Dojlido found 0.6 ppm/hr removed in a river die-away test.

Methyl Isobutyl Ketone (4-Methyl-2-Petanone)

4-Methyl-2-pentanone is not expected to be highly persistent in the environment. Although it would be expected to volatilize relatively rapidly, its moderate water solubility would probably limit its evaporation from aqueous media. It is expected to undergo oxidation in the atmosphere. Based on its low log octanol/water partition coefficient (1.18), it probably does not undergo significant sorption to sediments. Biodegradation is probably its main environmental fate (Clement Associates, Inc., 1985).

Nickel

Nickel is a naturally occurring metal that exists predominantly in the divalent oxidation state. Nickel is mined and is used to produce steel and other alloys; for plating; in batteries, ceramics, and fuel cells; and as an industrial catalyst. Soil levels may be increased by applying sewage sludge, the use of some fertilizers, and aerosol deposition. Nickel is released to the atmosphere primarily through the burning of fuel oil. Secondary sources of anthropogenic nickel emissions include nickel mining and refining and incineration. In general, nickel is the most mobile of the heavy metals (ATSDR, 1987b).

Nickel in the atmosphere occurs primarily in the aerosol form. It is removed mainly by wet and dry deposition. The aerate residence time of nickel in the air is 7 days, during which time substantial long-distance transport (up to thousands of kilometers) can occur (ATSDR, 1987b).

Nickel is highly persistent in water and soils. In aqueous systems its form and solubility depends upon the physical and chemical properties of the water. At or below pH 9 under aerobic conditions, nickel forms moderately soluble compounds with naturally occurring ligands (e.g., hydroxide, sulfate, chloride). The hydroxides and carbonates will precipitate above pH 9. Insoluble sulfides may form under reducing conditions. In organic-rich polluted waters, nickel forms stable, soluble organic complexes. Limited evidence suggests that in environments in which organic material is low, nickel may be coprecipitated or sorbed by hydroxides of iron, silica, and manganese, thereby decreasing its mobility and bioavailability. The immobilization of nickel by adsorption onto organic matter in sediments may also play a greater role in organic-poor unpolluted aquatic systems (ATSDR, 1987b).

Nickel speciation in soil is expected to be similar to that found in water; nickel ferrite is probably the most common precipitated form. Factors that decrease the mobility of nickel in soil include increased pH (basic), organic matter, and iron concentrations (ASTDR, 1987b).

Available data indicate that nickel does not significantly bioaccumulate in fish; bioconcentration factors are less than 100. Bioconcentration factors for aquatic invertebrates and plants have usually been reported to be in the range of 100 to 1,000. Nickel accumulates at high concentrations in some terrestrial plants, including soybeans and jack beans (ASTDR, 1987b).

Phthalate Esters

Bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, dibutyl phthalate, and diethy phthalate constitute a group of phthalic acid esters used primarily as plasticizing agents in the production of polyvinyl chloride resins (U.S. Int. Trade Comm., 1978). In soil, adsorption onto particles high in organic matter represents the most important fate process. Interactions with fulvic acids present in humic substances are associated with the formation of highly soluble complexes. Biodegradation and metabolism by multicellular organisms are also considered important fate processes in soil. (Clement Associates, Inc., 1985).

In water, the solubilities of the phthalate esters range from sparingly to moderately soluble. Adsorption onto suspended particulates and biota is expected to be an important fate process. Under certain aquatic conditions, the formation of soluble complexes with humic substances may occur. Bioaccumulation, biotransformation, and biodegradation represent the dominant aquatic fate processes. Mixed microbial systems readily degrade phthalate esters under aerobic conditions. Anaerobic conditions result in slower degradation of the phthalate esters. Degradation of bis(2-ethylhexyl) phthalate is known to cease. The phthalate esters are known to undergo hydrolysis; however, this process is recognized as being slow (Callahan, et al., 1979).

Owing to low vapor pressures (<0.01 mm Hg at 20°C for dimethyl and diethyl phthalates), the atmosphere is not expected to be a significant media for release (Patty, 1963). Volatilization has been reported from plastics exposed to high temperatures. The phthalate esters have been reported to undergo degradation via hydroxyl radical attack; however, this is considered too slow to be environmentally significant (Callahan, et al., 1979).

Phenolic Compounds

Phenolic compounds include a wide variety of organic chemicals. The phenols may be classified into monohydric, dihydric, and polyhydric phenols, depending upon the number of hydroxyl

groups attached to the aromatic ring. Phenol itself, which has one hydroxyl group, is the most typical of the group and is often used as a model compound. The properties of phenol, with certain modification depending on the nature of the substituents on the benzene ring, are shared by other phenolic compounds. Phenolic compounds arise from the distillation of coal and wood; from oil refineries and chemical plants; human organic wastes; hydrolysis, chemical oxidation, and microbial degradation of pesticides; and from naturally occurring sources and substances. Some compounds are refractory to biological degradation and can be transported long distances in water.

1,1,2,2-Tetrachloroethane

1,1,2,2-Tetrachloroethane is used commercially as a solvent and in the production of pesticides, bleaches, paints, and varnishes. Because of its relatively high vapor pressure (5 mm Hg at 20°C), volatilization is expected to be its primary transport process from surface waters. Limited experimental evidence suggests that photolysis in aqueous systems would not be a significant fate process; indirect evidence from studies on 1,1,1-trichloroethane suggests that oxidation is also not important. Also based on experiments on 1,1,1-trichloroethane, the half-life of 1,1,2,2-tetrachloroethane due to hydrolysis is expected to be on the order of several months to several years. Data regarding the potential for the sorption of 1,1,2,2-tetrachloroethane to sediments or for bioaccumulation in aquatic organisms are inconclusive. Studies on other chlorinated aliphatics indicate that biodegradation, if it occurs, is probably very slow. Data for 1,1,1-trichloroethane suggest that volatilized 1,1,2,2-tetrachloroethane will probably undergo significant photooxidation in the troposphere and photolysis by high-energy ultraviolet light in the stratosphere (Versar, 1979). Some 1,1,2,2-tetrachloroethane may be removed from the atmosphere by wet deposition.

Tetrachloroethene

Tetrachloroethene (PCE) volatilizes rapidly into the atmosphere, reacting with hydroxyl radicals to produce HCl, CO, CO_2, and carboxylic acids. The half-life of PCE was estimated in a simulated atmospheric photodecomposition study to be 1-20 to 40 hours (Dilling, et al., 1976). In another laboratory study, 1 ppm of PCE rapidly evaporated from agitated water. After 30 minutes, 50 percent of the initial PCE evaporated, and in less than 90 minutes, 90 percent of the PCE evaporated. The hydrolytic oxidation reaction half-life for PCE in sealed ampules was 6 to 18 months.

PCE leaches into groundwater, especially in soils of low organic content. In soils with high levels of organics (silts, clays, peats), PCE adsorbs readily to these materials (Clement Associates, Inc., 1985).

Toluene

The main transport process for removing toluene from water and soil is volatilization. Once in the air, photochemical reactions dissociate toluene to form a benzyl radical. Further oxidation follows the path of benzene, with the principal organic product being benzaldehyde. Inferences based on smog-chamber data suggest a half-life for toluene of 15 hours, an estimate that is applicable only to metropolitan areas (Versar, 1979).

Toluene is characterized by relatively low water solubility, suggesting little potential for accumulation in an aquatic environment. Although studies have shown that toluene can be adsorbed by sedimentary organic material and degraded by soil bacteria, the importance of these fate processes relative to volatilization is unknown (Versar, 1979).

1,1,1-Trichloroethane (TCA)

1,1,1-Trichloroethane has a high volatilization rate relative to many other organic chemicals, due to its high vapor pressure, even though its solubility is low. The primary fate pathway for this chemical is volatilization from surface water or soil, followed by slow photooxidation in the atmosphere. Atmospheric lifetime due to photooxidation for 1,1,1-trichloroethane is on the order of 6 to 10 years. Studies conducted in static cultures indicate the potential for 1,1,1-trichloroethane to biodegrade in the environment and in waste treatment processes (Versar, 1979).

Trichloroethene

Trichloroethene (TCE) is a common anthropogenic contaminant of soil and groundwater. Sources of TCE release to the environment include its use as a chemical intermediate in the production of pesticides, wax, resin, tar, paint, and varnish, as well as direct use as a degreasing solvent and dry cleaning agent.

Biodegradation, hydrolysis, oxidation, and photooxidation are extremely slow compared with volatilization for TCE in surface waters and surface soils. TCE is thought to be relatively resistant to biodegradation, but both oxidative and anaerobic transformation have been reported. Cis- and trans-1,2-dichloroethene are reported to be degradation products (Bouwer and McCarty, 1983).

TCE transport through soil is usually fairly rapid, but the percentage of organic matter, soil particulate size, and degree of soil saturation with water affect the migration rate. Organic matter and smaller particle size impede migration. In addition, dissolved TCE may behave differently from pure TCE, but data are not available to distinguish precisely how their behaviors may vary.

Trichlorofluoromethane

Trichlorofluoromethane has been commonly used as a refrigerant, solvent, and propellant. Because of its high vapor pressure (667 mm Hg at 20°C), it rapidly volatilizes to the atmosphere.

Trichlorofluoromethane is stable in the troposphere; residence times ranging from 10 to 1,000 years have been postulated. Small amounts of trichlorofluoromethane may be removed from the troposphere by wet deposition, but most eventually migrates to the stratosphere. In the stratosphere, trichlorofluoromethane dissociates as a result of attack by high-energy, short-wavelength ultraviolet light. Evidence indicates that the dissociation produces two chlorine atoms that are subsequently involved in the destruction of the stratospheric ozone layer (Versar, 1979).

Volatilization is expected to be the major transport process of trichlorofluoromethane in aquatic systems. Trichlorofluoromethane has a low solubility in water (1,100 mg/L at 20 to 25°C). There is a lack of data regarding the sorption of trichlorofluoromethane to sediments, although based on its log octanol/water partition coefficient (2.3), some sorption may be possible. Hydrolysis under ambient water conditions appears to be negligible. Bioaccumulation of trichlorofluoromethane has not been demonstrated in aquatic organisms. Although trichlorofluoromethane is lipophilic and could theoretically potentially bioaccumulate, its high volatility makes it unlikely to persist in surface waters, reducing the chance for bioaccumulation. Similarly, although biodegradation cannot be ruled out as a fate process for trichlorofluoromethane, it is unlikely to be significant due to rapid volatilization.

Vinyl Chloride

Vinyl chloride is a synthetically produced chemical that is used almost exclusively in the production of polyvinyl chloride and other polymers. Release to the environment appears to be primarily from emissions and effluents from plastics industries.

Because of its high vapor pressure (2,660 mm Hg at 25°C), volatilization is its major transport mechanism. It is expected that virtually all vinyl chloride in the atmosphere exists as a vapor. Photooxidation in the troposphere, resulting from attack by hydroxyl radicals, is its main fate. The half-life for this reaction has been estimated to be in the range of 1 to 1.5 days. Its half-life is expected to be on the order of several hours in photochemical smog. Some of the photooxidation products include hydrogen chloride, formyl chloride, formaldehyde, carbon monoxide, carbon dioxide, acetylene, and water. Wet and dry deposition are not expected to be important processes in removing vinyl chloride from the atmosphere (ATSDR, 1988).

The half-life of vinyl chloride in surface water due to volatilization has been experimentally estimated to range from approximately 9 hours for a river to 43 hours for a pond. Photodegradation may be an important degradation process in surface waters containing photosensitizers such as humic acid. Limited evidence suggests that the sorption of vinyl chloride to sediments is negligible and that it is resistant to biodegradation under aerobic conditions. Based on limited studies, its low log octanol/water partition coefficient (approximately 0.6), and its rapid volatilization from surface water, vinyl chloride is not expected to bioaccumulate in aquatic organisms (ASTDR, 1988).

Because of its low sorption to solids and high vapor pressure, vinyl chloride is expected to rapidly evaporate from and not to persist in surface soils. Its low sorptive capacity also suggests that it will be mobile in soil, potentially leaching into groundwater (ASTDR, 1988). Laboratory studies indicate that vinyl chloride may degrade to carbon dioxide and chloride in groundwater; it has been reported that its presence in groundwater may also result from the degradation of trichloroethane and tetrachloroethene (Versar, 1979).

Xylenes

Xylenes occur as one of three isomers (ortho-, meta-, and para-); all are components of gasoline. They are also used as industrial solvents. Xylenes occur as liquids, are lighter than water, and in pure product form may be found floating on top of the water table. The relatively low water solubilities and high log octanol/water partition coefficients for the isomers suggest that xylenes are significantly adsorbed by organic matter in the subsurface.

4.2.5 Background Levels

An evaluation of the significance of environmental contaminant concentrations is typically based on a comparison of the levels observed to known background conditions and regulatory-based standards, where applicable. It should be noted in reviewing the results for Selfridge ANGB that the contract SOW did not include any sampling of background water, surface water, or soils off Selfridge ANGB property. Some sampling points were chosen as upgradient of areas of contamination to serve as background points for these specific sites. As the information collected at each site has enhanced the understanding of the character of Selfridge ANGB conditions, areas that were once believed to be upgradient are no longer. It is, therefore, necessary to obtain background information by other means.

A number of studies in the literature have been made of naturally occurring elements and compounds for different areas of the United States (as well as the world). From these studies

it can be stated that soil contains a large variety of naturally occurring organic compounds, metallic elements, and semi-metallic elements. It must also be noted that each soil type for an area has its own characteristic concentration ranges of elements and compounds.

Table 4-18 lists functional groups and individual organic compounds that have been detected in naturally occurring soils and individual compounds and ranges of concentrations detected. This information has been collected from the literature by Dragun (1988). The list presented in this report is an abstract of the information Dragun collected and is primarily compounds of interest to Selfridge ANGB. Except for the listed compounds and functional groups, the organic parameters analyzed in this investigation (volatile organic compounds (VOCs), base-neutral and acid-extractable compounds (BNAs)) are manmade compounds. Because none of the organic compounds that occur naturally were found in a significant percentage of soil samples collected at Selfridge ANGB, any occurrence of these compounds in environmental media was generally taken to be above natural background levels.

Analysis of the investigative soil samples of Selfridge ANGB by metals screen revealed that a number of metals, such as aluminum, magnesium, manganese, and barium, occurred in significant concentrations in almost every sample. In order to interpret when the detected elemental concentrations may be due to manmade contamination, some interpretation of the background levels of the soils must be made. The USGS produced a study of the ranges of concentrations that elements are found in naturally occurring soils for the eastern conterminous United States. The results of this study are summarized in Table 4-19. In order to compare these ranges with ranges found at Selfridge ANGB, histograms were produced of the occurrence of each element. Each histogram graphed the results of an individual element's analysis for all soil samples collected at Selfridge ANGB. The analytical results were sorted so that each histogram shows detections from lowest to highest concentrations. Each histogram was then compared to observed ranges at Selfridge ANGB as reported in Table 4-20. If large numbers of samples within a histogram had concentrations in a "plateau" and close to the estimated mean listed in Table 4-19, these values were determined to be background at Selfridge ANGB. The standard deviation and variance calculated for all the detections of an element were then compared to the values determined by the histograms to be background, and a background range was identified. This evaluation gave a qualitative assessment of the data, although it is not a rigorous statistical exercise. Table 4-20 lists the estimated background ranges for soils at Selfridge ANGB. All the histograms are found in Appendix N.

As can be seen from Table 4-20, all concentrations of aluminum, beryllium, iron, potassium, magnesium, sodium, and silicon detected in soils sampled at Selfridge ANGB are within estimated

Table 4-18

Naturally Occurring Organic Chemicals Found in Soil,
IRP Stage 2, Selfridge ANGB, MI

Functional Group	Concentration (mg/kg)
n-Alkanes, c <34	0-286
Alkylbenzenes	
Alkylnaphthalenes	
Alkylphenanthrenes	
Alkylphthalates	0-60.6
Cyclic alkanes	
Phthalates	<50
<u>Individual Compounds</u>	
Anthracene	<5
Benzo(a)anthracene	0-0.1
Benzene	1-5
Benzo(b)fluoranthene	0-0.03
Benzo(k)fluoranthene	0-0.015
Benzo(g,h,i)perylene	0-0.02
Benzo(a)pyrene	0-8
Benzyl butyl phthalate	0-48
Bis(2-ethylhexyl) phthalate	150-925
n-Butanol	0-1,220
Carbon disulfide	<5
Chrysene	1-5
Dibutyl phthalate	19-56
Dioctyl phthalate	0-13
Ethylbenzene	1-5
Fluoranthene	0-0.04
Indeno(1,2,3-c,d)pyrene	0-0.015
Methane	1->1,000
Naphthalene	1-5
Pyrene	0-0.015
Toluene	1-5
o-Xylene	1-5
m-Xylene	1-5
p-Xylene	1-5

Adapted from Dragun, 1988.

Table 4-19

Ranges of Concentration of Elements
Found in Soils in Eastern United States,
IRP Stage 2, Selfridge ANGB, MI

Element	Mean	Standard Deviation	Observed Range	Estimated Arithmetic Mean
Al, percent	3.3	2.87	0.7 - >10	5.7
As	4.8	2.56	<0.1 - 73	7.4
B	31	1.88	<20 - 150	38
Ba	290	2.35	10 - 1,500	420
Be	0.55	2.53	<1 - 7	0.85
C, percent	1.5	2.88	0.06 - 37	2.6
Ca, percent	0.34	3.08	0.01 - 28	0.63
Cd	1.1	2.45	0.01 - 45	1.5
Co	5.9	2.57	<0.3 - 70	9.2
Cr	33	2.60	1 - 1,000	52
Cu	13	2.80	<1 - 700	22
F	130	4.19	<10 - 3,700	0
Fe, percent	1.4	2.87	0.01 - >10	2.5
Hg	0.081	2.52	0.01 - 3.4	0.12
K, percent	1.2	0.75	0.005 - 3.7	--
Mg, percent	0.21	3.55	0.005 - 5	0.46
Mn	260	3.82	<2 - 7,000	640
Mo	0.32	3.93	<3 - 15	0.79
Na, percent	0.25	4.55	<0.05 - 5	0.78
Ni	11	2.64	<5 - 700	18
P	200	2.96	<20 - 6,800	360
Pb	14	1.95	<10 - 300	17
S, percent	0.10	1.34	<0.08 - 0.31	0.11
Sb	0.52	2.38	<1 - 8.8	0.76
Se	0.30	2.44	<0.1 - 3.9	0.45
Si, percent	34	6.64	1.7 - 45	--
Tl	7.7	1.58	2.2 - 23	8.6
V	43	2.51	<7 - 300	66

Concentrations in mg/kg, except as noted.
Adapted from USGS Prof. Paper 1270.

Table 4-20

Statistical Evaluation of Metals In Soil, IRP Stage 2, Selfridge ANGB, MI

Element	Number of Detects in 62 Soil Samples	Minimum	Median	Maximum	Average	Standard Deviation	Estimated Background
Silver	0	--	--	--	--	--	--
Aluminum	62	2,260	12,300	19,700	11,177.58	4,370.344	19,700
Arsenic	37	4.65	13.3	43.2	15.81	8.1856	20
Boron	33	20.3	26.4	52.9	26.82	5.74102	36
Barium	62	12.9	95.5	159	86.19	36.1537	159
Beryllium	57	0.21	0.76	1.2	0.72	0.2319	1.2
Calcium	62	948	41,700	83,200	40,993.51	1,515.71	83,200
Cadmium	33	1.0	5.35	32.5	2.25	5.35	2
Cobalt	57	4.1	3.68	21.7	10.69	3.68	14.2
Chromium	62	5.47	6.36	31.1	18.18	6.36	31.1
Copper	62	3.7	7.32	44.1	17.01	7.32	25
Iron	62	3,650	6,735.51	27,600	19,418.22	6,735.51	27,600
Mercury	1	0.9597	--	0.9597	0.9597	--	--
Potassium	48	991	943.17	4790	2,413.77	943.17	4,790
Magnesium	62	709	5,732.12	25,500	3,013.37	5,732.12	25,500
Manganese	62	28.9	565.31	1,360	397.82	235.92	501
Molybdenum	0	--	--	--	--	--	--
Sodium	59	90.8	381	2,150	680.94	565.31	2,150
Nickel	61	5.6	60.35	382	37.77	60.35	41.8
Lead	2	22.5	--	82.2	52.35	--	--
Antimony	0	--	--	--	--	--	--
Selenium	0	--	--	--	--	--	--
Silicon	61	34.5	194	730	214.55	148.89	730
Thallium	0	--	--	--	--	--	--
Vanadium	62	6.59	25.4	42.1	23.71	8.27	42.1
Zinc	61	10.8	59.9	95.6	54.34	16.77	70

Concentrations in mg/kg.

background ranges. These are, for the most part, elements that are major components of the clay minerals that make up the soils at the base. No definite background value could be determined exactly from histograms for arsenic, barium, chromium, or vanadium, as the distribution of the concentrations for these elements fell within wide ranges. For barium, chromium, and vanadium, all values detected at Selfridge ANGB occurred below the mean concentrations for these elements for the eastern U.S. (see Table 4-19), and therefore, they would appear to be naturally occurring. For arsenic, however, most of the concentrations detected occurred above the mean concentrations for the eastern U.S. (see Table 4-19). It was, therefore, decided, based upon mean values and standard deviation, that concentrations above 20 mg/kg may be due to manmade contamination. Elements boron, cadmium, cobalt, copper, nickel, manganese, and zinc have definitive plateaus in their histograms, indicating differing populations and ranges for background population and affected population. Elements lead and mercury were found in only a few samples and in concentrations above the naturally occurring mean. Therefore, the detections are believed to be due to contamination.

Uncontaminated groundwater and surface water will have dissolved major and trace elements and compounds characteristic of the soils or subsurface that it flows over or through. Table 4-21 lists typical dissolved constituents of groundwater. A number of these inorganic compounds and elements were detected in Selfridge ANGB groundwater and surface water. As none of the organic compounds analyzed for occurred in a significant portion of the waters at Selfridge ANGB, it is assumed that any detection of organic compounds that did occur was due to manmade compounds and, therefore, contamination. However, a number of the indicator parameters and elemental concentrations occur in most of the water samples. Histograms were prepared of all the analytical data for each of these indicator parameters and elements. The histograms were prepared for surface water and groundwater. Each sampling round was analyzed separately for surface water and groundwater, as seasonal changes may affect the concentrations of the analyzed parameters. The analytical data were sorted for each parameter so that the histograms listed the data from low values to high values. Each histogram was compared to the ranges observed at Selfridge ANGB reported in Tables 4-22 and 4-23 for groundwater and surface water, respectively. If large numbers of samples within a histogram had concentrations in a plateau and close to the typicals shown in Table 4-21, these values were determined to be background at Selfridge ANGB. The standard deviation and variance calculated for all the detections of an element were then compared to the values determined by histogram to be background, and a background range was identified. Table 4-22 lists the estimated background ranges for groundwater at Selfridge ANGB, and Table 4-23 lists the estimated background ranges for surface water at Selfridge ANGB. All the histograms are found in Appendix O.

Table 4-21

Natural Concentrations of Various Species in Groundwater, IRP Stage 2, Selfridge ANGB, MI

Species	Concentration: Typical Value	Concentration: Extreme Value
	--Major Species (ppm)--	
Calcium	1.0-150	95,000
Chloride	1.0- 70	200,000
Fluoride	0.1- 5.0	70
Iron	0.01-10	>1,000
Potassium	1.0- 10	25,000
Magnesium	1.0- 50	52,000
Sodium	0.5-120	120,000
Nitrate	0.2- 20	70
Silica	5.0-100	4,000
Sulfate	3.0-150	200,000
	--Trace Species (ppb)--	
Silver	<5.0	
Aluminum	<5.0-1,000	
Arsenic	<1.0- 30	4,000
Boron	20- 1,000	5,000
Barium	10- 500	
Beryllium	<10	
Cadmium	<1.0	
Cobalt	<10	
Chromium	<1.0- 5.0	
Copper	<1.0- 30	
Mercury	<1.0	
Manganese	<1.0-1,000	10,000
Molybdenum	<1.0- 30	10,000
Nickel	<10- 50	
Phosphate	<100- 1,000	
Lead	<15	
Selenium	<1.0- 10	
Vanadium	<1.0- 10	70
Zinc	<10- 2,000	

Adapted from Dragun, 1988.
Typical values are for humid regions; extreme values are for brines, thermal springs, or mine areas.

Table 4-22

Statistical Evaluation of Metals, Anions, and Indicator Parameters in Groundwater, IRP Stage 2, Selfridge ANGB, MI

Parameter	No. of Detects/ No. of Samples	Minimum	Median	Maximum	Average	Std. Dev.	Estimated Background
Chloride	69/69	1.74	105	6,800	415.98	927.15	152
Sulfate	58/69	2.7	82.6	962	121.84	152.57	165
Alkalinity	68/68	100	470	5,700	543.24	713.07	670
TDS	66/67	350	1,200	13,000	1655.45	2183.31	1,400
Petroleum hydrocarbons	25/63	1	1.4	4.3	1.68	0.853697	0
COD	30/31	18	57	7,000	401.33	1269.42	100
Ammonia	32/32	0.3	0.7	12	1.58	2.16	12
TOC	31/31	2.7	8.8	2,000	109.94	395.17	52
Barium	33/43	0.052	0.174	0.929	0.107	0.242	0.421
Zinc	23/43	0.011	0.021	0.105	0.031	0.026	0.105

Concentrations in mg/L.

Table 4-23

Statistical Evaluation of Metals, Anions, and Indicator Parameters in Surface Water, IRP Stage 2, Selfridge ANGB, MI

Parameter	No. of Detects/ No. of Samples	Minimum	Median	Maximum	Average	Std. Dev.	Estimated Background
Dry-Event							
Chloride	25/26	3.3	43.3	1,340	139.93	298.14	186
Sulfate	25/26	10.7	27.6	199	38.36	37.99	100
Alkalinity	26/26	70	320	620	340.38	125.59	620
TDS	20/24	100	460	2,500	518.5	476.62	690
Petroleum hydrocarbons	17/26	1.1	1.7	4.6	1.88	0.79	0
COD	13/13	10	41	390	79.08	101.71	57
Ammonia	13/13	0.1	0.4	1.1	0.45	0.28	1.1
TOC	13/13	4	8.3	52	14.65	13.14	52
Barium	11/17	0.051	0.101	0.518	0.167	0.141	0.354
Zinc	15/17	0.011	0.036	0.44	0.068	0.106	0.44
Wet-Event							
Chloride	29/30	3	50	1,280	175.85	286.36	328
Sulfate	29/30	5.8	49.6	325	60.97	61.62	105
Alkalinity	30/30	72	290	2,500	392.48	446.36	680
TDS	29/30	110	420	2,000	547.08	418.92	1,400
Petroleum hydrocarbons	28/30	1.1	1.6	3.6	1.72	0.53	0
COD	9/12	11	39	80	47.44	22.18	80
Ammonia	10/12	0.2	0.3	1.8	0.55	0.49	1.8
TOC	12/12	6.1	15	100	22.48	25.07	34
Barium	9/16	0.052	0.155	1.31	0.297	0.373	0.385
Zinc	14/16	0.013	0.056	0.943	0.145	0.231	0.943

Concentrations in mg/L.

Chloride occurs naturally in groundwater from 1.0 to 70 mg/L in humid regions, according to Table 4-21. The histogram of chloride occurrence in base groundwater indicates there are two populations, a background range of 1.74 to 152 mg/L, and an affected population with a range of 201 to 6,800 mg/L. Sulfate occurs naturally in groundwater from 3.0 to 150 mg/L in humid regions, according to Table 4-21. The histogram of sulfate occurrence in base groundwater indicates there are two populations, a background range of 2.7 to 165 mg/L, and an affected population with a range of 205 to 962 mg/L. The histogram of alkalinity in base groundwater indicated a background population with a range of 100 to 670 mg/L and an affected population with a range of 790 to 5,700 mg/L. The histogram of total dissolved solids in base groundwater indicated a background population with a range of 350 to 1,400 mg/L and an affected population with a range of 1,700 to 13,000 mg/L.

Among the other indicator parameters in groundwater, COD has a background population of 18 to 100 mg/L, ammonia a background population of 0.3 to 12 mg/L, and TOC a background population of 2.7 to 52 mg/L. All petroleum hydrocarbons are believed to be contaminants. Among the metals, barium occurs naturally in groundwater from 10 to 500 mg/L. The distribution of barium occurrence in groundwater fell within wide ranges, but based on its natural occurrence, a background range of 0.052 to 0.421 mg/L and an affected population of 0.518 to 0.929 mg/L are identified. All of the zinc occurrences in groundwater appear to be within background ranges.

Histograms indicated most of the detections occurred in background ranges for the indicator parameters, anions, and barium, in both the wet-event and dry-event surface water samples. Four chloride detections, two sulfate detections, one alkalinity detection, two total dissolved solids detections, three COD detections, one TOC detection, and two barium detections occurred in concentrations believed to be due to contamination. All petroleum hydrocarbons detections are believed to be due to contamination. All zinc detections occurred in background ranges.

4.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The IRP Stage 2 study was conducted to be consistent with the requirements of the Superfund Amendments and Reauthorization Act of 1986 (SARA). One of the unique requirements of SARA (Section 121 (d)) is consideration of applicable or relevant and appropriate requirements -- ARARs. The ARARs are requirements, criteria, or limitations imposed by Federal, state, or other involved governmental entities. Determination of appropriate remedial actions at IRP sites, therefore, requires consideration not only of SARA, but also the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and other Federal, state, local and, in this case, international environmental laws.

Based upon readily available materials, a compilation of chemical-specific, location-specific, and action-specific ARARs was prepared. Chemical-specific ARARs set health- and risk-based concentrations or discharge limits for specific hazardous substances. Location-specific requirements are restrictions placed on remedial actions conducted at a specific location. Action-specific requirements are restrictions that set performance and design standards.

The regulations that may apply to the alternatives developed for the Selfridge ANGB sites are either applicable or relevant and appropriate. The National Contingency Plan (NCP) provides the following definitions:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law which specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law which, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, or circumstance at a CERCLA site," address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site.

CERCLA, amended by Congress under SARA in 1986, in effect codified EPA's existing approach to compliance with other laws. Section 121 establishes cleanup standards for remedial actions under 104 and 106 of CERCLA. Remedial actions must attain a general standard of cleanup that must assure protection of human health and the environment, be cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, for any material that will remain on the site, the level or standard of control that must be met for the hazardous substance, pollutant, or contaminant is at least that of any legally "applicable or relevant and appropriate" standard, requirement, criterion, or limitation promulgated pursuant to a state environmental statute.

4.3.1 Federal ARARs

Federal statutes that SARA specifically sites as potential ARARs include:

- Toxic Substances Control Act (TSCA).
- Safe Drinking Water Act (SWDA).
- Clean Air Act (CAA).
- Clean Water Act (CWA).
- Marine Protection Research and Sanctuaries Act.
- Solid Waste Disposal Act.

Remedial action is to at least attain the standards of the Maximum Contaminant Level Goals (MCLGs) of the Safe Drinking Water Act and the water quality criteria of the Clean Water Act. For off-site actions, SARA allows the transfer of hazardous substances, pollutants, or contaminants only at a facility that is in compliance with RCRA (or in compliance with TSCA or other Federal laws where applicable). Where state requirements would result in a state-wide prohibition of land disposal of hazardous substances, the state requirement will not be applicable.

For the sake of clarity and brevity, Federal ARARs are presented in tabular form. Table 4-24 presents Federal chemical-specific ARARs, Table 4-25 presents Federal location-specific ARARs, Table 4-26 presents Federal action-specific ARARs, and Table 4-27 presents Federal environmental laws and regulations that are not ARARs at Selfridge ANGB.

4.3.2 State of Michigan ARARs

Potentially applicable regulations include Michigan's:

- Hazardous Waste Management Act.
- Underground Storage Tank Act.
- Air Pollution Control Commission Rules.
- Michigan Solid Waste Management Act.
- MDNR-Water Resources Commission Wastewater Rules.
- Soil and Erosion Control Act.
- Liquid Industrial Disposal Act.
- MDNR-Water Resources Commission Water Quality Standards.
- Michigan Environmental Response Act.

Because MDNR did not respond to follow-up correspondence, the following discussion of ARARs may be incomplete.

Table 4-24

Potential Federal Chemical-Specific ARARs,
IRP Stage 2, Selfridge ANGB, MI

Chemical	Clean Water Act Freshwater Toxicity Criterion -- Acute (mg/L)	Clean Water Act Freshwater Toxicity Criterion -- Chronic (mg/L)	EPA Ambient Water Quality Criteria for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)	EPA Ambient Water Quality Criteria for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
1,1,1-Trichloroethane			1.84E+01	1.9E+01
1,1,2,2-Tetrachloroethane		2.4E+00	0 (1.7E-03)***	(1.7E-03)
1,1-Dichloroethene	1.2E+01**		0 (3.3E-04)	(3.3E-04)
1,2-Dichlorobenzene			4.0E-01	4.7E-01
1,2-Dichloroethane	1.2E+02**	2.0E+01**	0 (9.4E-03)	(9.4E-03)
1,3-Dichlorobenzene			4.0E-01	4.7E-01
1,4-Dichlorobenzene			4.0E-01	4.7E-01
2,4-Dimethylphenol	2.1E+00**		4.0E-01 (organoleptic)****	4.0E-01 (organoleptic)
Arsenic			0 (2.2E-05)	(2.5E-05)
Barium				
Benzene	5.3E+00**		0 (6.6E-03)	(6.7E-03)
Beryllium	1.3E-01**	5.3E-03**	0 (3.7E-05)	(3.9E-05)
Cadmium	3.9E-03	1.1E-03	0 (1.0E-02)	(1.2E-02)
Chlorobenzene			4.88E-01	4.88E-01
Chloroform	2.9E+01**	1.2E+00**	0 (1.9E-03)	(1.9E-03)
Chromium (hexavalent)			5.0E-02	5.0E-02
Chromium (trivalent)	1.7E+00	2.1E-01	1.7E+02	1.7E+02
Copper	1.8E-02	1.2E-02	1.0E+00 (organoleptic)	1.0E+00 (organoleptic)
Diethyl phthalate			3.5E+02	4.34E+02
Dimethyl pathalate			3.13E+02	3.5E+02
Ethylbenzene	3.2E+01**		1.4E+00	2.4E+00
Fluoranthene			4.2E-02	1.88E-01
Fluoride				
Lead	8.2E-02	3.2E-03	5.0E-02	5.0E-02
Mercury	2.4E-02	1.2E-05	1.44E-04	1.0E-02
Naphthalene			Insufficient data	Insufficient data
Nickel	1.4E+00	1.6E-01	1.34E-02	1.54E-02
Nitrate*				
Pentachlorophenol	2.0E-02	1.3E-02	1.01E+00	1.01E+00
Phenol	1.0E+01**	2.5E+00**	3.5E+00	3.5E+00
Selenium			1.0E-02	1.0E-02
Silver			5.0E-02	5.0E-02
Tetrachloroethene	5.3E+00**	8.4E-01**	0 (8.0E-03)	8.8E-03
Toluene	1.7E+01**		1.43E+01	1.5+01
Trichloroethene	4.5E+01**	2.2E+01**	0 (2.7E-02)	(2.8E-02)
Vinyl chloride			0 (2.0E-02)	(2.0E-02)
Xylenes				
Zinc			5.0E+00 (organoleptic)	5.0E+00 (organoleptic)

* As nitrogen.
** Lowest observed efect level.
*** Concentrations in parentheses correspond to carcinogenic risk of 10E-05.

Table 4-24
(continued)

Chemical	RCRA Maximum Contaminant Level (MCL) (mg/L)	Proposed RCRA Media Protection Standards for Carcinogens -- Water (mg/L)	Proposed RCRA Media Protection Standards for Carcinogens -- Soil (mg/kg)
1,1,1-Trichloroethane	2.0E-01		
1,1,2,2-Tetrachloroethane		1.8E-05	1.8E-01
1,1-Dichloroethene	7.0E-03	5.8E-06	5.8E-02
1,2-Dichlorobenzene			
1,2-Dichloroethane	5.0E-03	3.8E-05	3.8E-01
1,3-Dichlorobenzene			
1,4-Dichlorobenzene			
2,4-Dimethylphenol			
Arsenic	5.0E-02		
Barium	1.0E+00		
Benzene	5.0E-03		
Beryllium			
Cadmium	1.0E-02	NA	NA
Chlorobenzene			
Chloroform	1.0E-01**	5.7E-04	5.7E+00
Chromium (hexavalent)	5.0E-02	NA	NA
Chromium (trivalent)			
Copper			
Diethyl phthalate			
Dimethyl phthalate			
Ethylbenzene			
Fluoranthene			
Fluoride	1.4E+00		
Lead	5.0E-02		
Mercury	2.0E-03		
Naphthalene			
Nickel		NA	NA
Nitrate*	1.0E+01		
Pentachlorophenol			
Phenol			
Selenium	1.0E-02		
Silver	5.0E-02		
Tetrachloroethene		6.9E-05	6.9E-01
Toluene			
Trichloroethene		3.2E-04	3.2E+00
Vinyl chloride	2.0E-03		
Xylenes			
Zinc			

* As nitrogen.
** Sum concentration must be less than 0.1 mg/L for four trihalomethanes of which chloroform is one.
NA Not applicable because these constituents are carcinogenic through the inhalation route alone.

Table 4-24
(continued)

Chemical	Safe Drinking Water Act Maximum Contaminant Level (MCL) (mg/L)	Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG) (mg/L)	Safe Drinking Water Act Proposed MCL** (mg/L)	Safe Drinking Water Act Proposed MCLG** (mg/L)
1,1,1-Trichloroethane	2.0E-01	2.0E-01		
1,1,2,2-Tetrachloroethane				
1,1-Dichloroethene	7.0E-03	7.0E-03		
1,2-Dichlorobenzene				
1,2-Dichloroethane	5.0E-03	0		
1,3-Dichlorobenzene				6.0E-01
1,4-Dichlorobenzene				7.5E-02
2,4-Dimethylphenol				
Arsenic	5.0E-02		3.0E-02	
Barium	1.0E+00		5.0E+00	5.0E+00
Benzene	5.0E-03	0		0
Beryllium				
Cadmium	1.0E-02		5.0E-03	5.0E-03
Chlorobenzene				1.0E-01
Chloroform	1.0E-01***			
Chromium (hexavalent)	5.0E-02		1.0E-01	
Chromium (trivalent)				
Copper				1.3E+00
Diethyl phthalate				
Dimethyl phthalate				
Ethylbenzene			7.0E-01	7.0E-01
Fluoranthene				
Fluoride	1.4E+00			
Lead	5.0E-02			0
Mercury	2.0E-03		2.0E-03	
Naphthalene				
Nickel				
Nitrate*	1.0E+01		1.0E+01	
Pentachlorophenol				
Phenol				
Selenium	1.0E-02		5.0E-02	
Silver	5.0E-02			
Tetrachloroethene			5.0E-03	0
Toluene			2.0E+00	2.0E+00
Trichloroethene		0		
Vinyl chloride	2.0E-03	0		
Xylenes			1.0E+01	1.0E+01
Zinc				

* As nitrogen.
** Proposed values as of October 1988.
*** Sum concentration must be less than 0.1 mg/L for four trihalomethanes of which chloroform is one.

Table 4-25

Potential Federal Location-Specific ARARs, IRP Stage 2, Selfridge ANGB, MI

Potential ARAR	Issues	Requirements	ARAR Status	
			Applicable	Relevant and Appropriate
• Coastal Zone Management Act	Assists states in managing the land and water resources in coastal zones.	Must comply with Michigan's plans, if any exist.		X

Table 4-26

Potential Federal Action-Specific ARARs, IRP Stage 2, Selfridge, MI

Potential ARAR	Issues	Requirements	ARAR Status: Applicable	ARAR Status: Relevant and Appropriate
<u>Resource Conservation and Recovery Act (RCRA)</u>				
• 40 CFR 261: Definition and identification of hazardous waste	RCRA (Part 261) establishes basic definitions of solid and hazardous wastes. Waste material and contaminated media are present at the site. Remedial actions may produce potentially hazardous residuals. Need to identify whether these materials are potentially subject to requirements under RCRA.	Waste is subject to regulation under RCRA if: 1. Waste exhibits one of four characteristics (ignitibility, corrosivity, reactivity, or EP toxicity; 2. Wastes are listed as hazardous; or 3. Wastes are mixture wastes listed as hazardous by RCRA regulations	X	
• 40 CFR 262: Standards for generators of hazardous waste	RCRA (Part 262) establishes regulations covering activities of generators of hazardous waste. Need to identify whether generator requirements extend to CERCLA.	Generator requirements include identification of waste generation activity, obtaining EPA ID number, recordkeeping, and use of uniform national manifest.	X	
• 40 CFR 263: Standards for transport of hazardous waste	RCRA (Part 263) establishes regulations covering the transport of hazardous waste. Need to identify whether these apply to off-site actions.	The transport of hazardous waste is subject to requirements including DOT regulations, manifesting, recordkeeping, and discharge cleanup.	X	
• 40 CFR 264: Standards for treatment of hazardous waste	RCRA (Part 264) establishes regulations covering the treatment, storage, and disposal of hazardous waste. Need to identify whether these apply to remedial actions at Selfridge ANGB.			

Table 4-26
(continued)

Potential ARAR	Issues	Requirements	ARAR Status: Applicable	ARAR Status: Relevant and Appropriate
• 40 CFR 264: Standards for treatment of hazardous waste (continued)	• Off-site incineration is considered.	Off-site incinerator would need to be permitted and fully compliant as defined by EPA's Off-Site Policy.	X	
	• On-site incineration is considered. It would require a mobile unit.	On-site incineration will have to meet the performance standards listed in 40 CFR 264.340-264.351. The requirements include waste analysis, monitoring, inspections, and closure standards. An incinerator burning hazardous waste must achieve a destruction removal efficiency of 99.99 percent for each principal organic hazardous constituent. If dioxins or PCBs are present, will have to achieve 99.9999 percent destruction. In addition, a trial burn or submittal of a trial burn plan is required (40 CFR 270.62 and 270.19) for a new hazardous waste incinerator.	X	
	• Contaminated groundwater would be collected and treated prior to discharge. Need to determine whether groundwater treatment constitutes RCRA treatment.	RCRA requirements for treatment apply if the waste is a RCRA waste and the activity constitutes treatment as defined by RCRA.	X	
• 40 CFR 264: Standards for disposal of hazardous waste	RCRA (Part 264) establishes regulations covering the disposal of hazardous waste. Remedial actions may leave wastes in place, consolidate wastes, or dispose of treatment residues on site. Need to determine how closure and disposal apply to this site.	The following are closure options:		
		Clean closure: Under this closure (264 Subpart G) guidance is that any contaminants left in the soil will not impact any environmental media in excess of agency-established levels that will result in a threat to human health and the environment. Must be met within the facility boundary.	X	

Table 4-26
(continued)

Potential ARAR	Issues	Requirements	ARAR Status: Applicable	ARAR Status: Relevant and Appropriate
• 40 CFR 264: Standards for disposal of hazardous waste (continued)		Landfill closure: Under this closure (264 Subpart N), the following elements are included: final cover to minimize erosion, accommodate settling, and maintain integrity; and cover/cap permeability of less than the natural subsoils or liner. In cludes post-closure maintenance and monitoring.	X	
		Hybrid closure: Under this closure, the purpose is to design a closure that combines the relevant and appropriate portions of Subtitle C Clean Closure and Subtitle C Landfill Closure in relation to site-specific requirements. This is accomplished under CERCLA authority rather than RCRA authority.	X	
		Minimum technology requirements under the HSWA amendments to RCRA, the minimum technology requirements include two or more liners, a leachate collection system, and for landfills, a leachate collection system at the top.		
		Land ban. Material at the site may be subject to land ban under Part 268. The land ban requires that the wastes subject to it must meet treatment standards before land disposal.	X	

Table 4-26
(continued)

Potential ARAR	Issues	Requirements	ARAR Status: Applicable	ARAR Status: Relevant and Appropriate
• 40 CFR 257: Standards for solid waste disposal facilities	RCRA Subtitle D (Part 257) establishes guidelines for land disposal facilities for nonhazardous solid waste. Remedial actions may leave wastes in place, consolidate wastes, or dispose of treatment residues on-site. Need to determine how closure and disposal apply to this site.	General requirements for land disposal facilities. Specific solid waste management issues are reserved for the state.	X	
<u>Clean Water ACT (CWA)</u>				
• 40 CFR 122, 125 National Pollutant Discharge Elimination System (NPDES)	This section of the CWA regulates the discharge of water into surface water bodies. The remedial alternatives may include the discharge of treated or untreated groundwater to Clinton River.	The State of Michigan has authorization to administer NPDES.	X	
• 40 CFR 403 Effluent Guidelines and Standards: Pretreatment Standards	This section establishes pretreatment standards (both general and categorical) for the control of pollutant discharges into POTWs. The remedial alternatives may include the discharge of treated or untreated groundwater to the local POTW.	Discharge to POTW must not cause pass-through interference, violation of specific prohibitions, or violators of local limitations or ordinances. POTW should either have an EPA-approved pretreatment program or have sufficient mechanisms to meet the requirements of the national pretreatment program in accepting CERCLA waste.	X	
<u>U.S. EPA Groundwater Protection Strategy</u>	The protection strategy does not involve applicable ARARs but does contain policy statements to be considered. The strategy includes classification of aquifers. Need to determine whether the groundwater protection strategy considered will cause groundwater restoration to be considered.	The strategy includes guidelines on classifying groundwater for EPA decisions affecting groundwater protection and corrective actions. Criteria include ecological importance, replaceability, and vulnerability considerations.		X

Table 4-26
(continued)

ential ARAR	Issues	Requirements	ARAR Status: Applicable	ARAR Status: Relevant and Appropriate
an Air Act (CAA)				
CAA Section 109 and 40 CFR 50 National Ambient Air Quality	Sets national ambient air quality standards to attain and maintain primary and secondary standards to protect public health and the environment. Need to determine how aspects apply to remedial actions.	Pre-Construction Review	X	
	Remedial actions that may result in new sources of air emissions including incineration and excavation.	Major-source permit, prevention of significant deterioration permit, nonattainment area permit, visibility permit.	X	
CAA Section III New Source Performance Standards	Promulgates standards for new sources of air emissions. Need to determine if apply to potential remedial actions.	Requirements are source-specific.	X	
upational Safety and lth Act				
29 CFR 1910 General standards for worker protection	Provide a safe work place.	General requirements in OSHA require employers to provide a work place free of harm.	X	
29 CFR 1910. Regulations for workers involved in hazardous waste operations.	Regulate training, protective equipment, proper handling of wastes, monitoring of employee health, site information, and emergency procedures for workers at hazardous waste operations.	Specific requirements in OSHA regulations.		X
ardous Materials nsportation Act				
49 CFR Parts 100 through 199 Transportation of hazardous materials	Regulates the transport of hazardous materials. Need to determine how this applies to remedial actions.	Specific DOT requirements exist for labeling, packaging, shipping papers/manifesting, and transport by rail, aircraft, vessel, and highway.		X

Table 4-26
(continued)

Potential ARAR	Issues	Requirements	ARAR Status: Applicable	ARAR Status: Relevant and Appropriate
<u>National Environmental Policy Act</u>				
• Section 102(2)(c)	The evaluation of the environmental impact of Federal actions. Need to determine the applicability of NEPA to the site remedial actions.	A statement of environmental impact is required.	X	
<u>Intergovernmental Review of Federal Programs Executive Order 12372</u>				
• 40 CFR 29	State and local coordination and review of proposed EPA-assisted projects.	EPA Administrator is required to communicate with state and local officials to explain the project, consult with other affected Federal agencies, and provide a comment period for state review.	X X	

Table 4-27

Federal Environmental Laws and Regulations Not Applicable or Relevant and Appropriate to the Alternatives, IRP Stage 2, Selfridge ANGB, MI

Law or Regulation	Analysis
Underground Injection Control Regulations	None of the technologies include the underground injection of materials.
Ocean Dumping Requirements	Implementation of the technologies does not include the dumping of any materials in the ocean.
Uranium Mill Tailing Rules	The sites contain no uranium mill tailings.
Radioactive Waste Rule -- High and Low	The sites do not contain high- or low-level radioactive waste.
Asbestos Disposal Rules	Asbestos was not measured at the base.
National Register of Historic Places	Implementation of the technologies will not affect sites on the register.
Wild and Scenic Rivers Act	Rivers on the national inventory will not be affected by technologies.
Protection of Threatened or Endangered Species Habitats	Implementation of the technologies will not affect threatened or endangered species and their habitat.
Conservation of Wildlife Resources	Implementation of the technologies will not affect areas of important wildlife resources.
TSCA Regulations of PCBs	No PCBs are known to contaminate the site.
Relocation Assistance and Property Acquisition	Implementation of the technologies should not require relocation of residences or businesses or acquisition of property. The sites are confined to the military base.
FIFRA Regulations of Pesticides	Sites do not contain significant amounts of pesticides.

Chemical-Specific State ARARs

The Hazardous Waste Management Act defines hazardous waste in general accordance with Federal definitions, but also regulates two additional toxic metals: copper-bearing waste that yields Extraction Procedure concentrations greater than 100 mg/L and zinc-bearing waste that yields Extraction Procedure concentrations greater that 500 mg/L.

Location-Specific State ARARs

The Hazardous Waste Management Act governs the placement of landfills in areas subject to flooding. The Solid Waste Management Act applies to the base's three solid waste landfills.

Action-Specific State ARARs

If hazardous materials are transported off site, provisions of the Hazardous Waste Management Act may apply to transportation. Conducting treatment of hazardous materials may be governed by provisions of the Hazardous Waste Act regulating owners and operators of waste treatment, storage, and disposal facilities. The treatment regulations provide specific design guidelines for monitoring, incineration, tanks, and other possible elements of remediation systems potentially to be employed at Selfridge ANGB. If remediation involves excavation or site grading, the Soil and Erosion Act and the Air Pollution Control Commission Rules may apply. Air Pollution Control Commission Rules may also apply if a remediation activity includes volatilization as a remedial technology.

4.3.3 International ARARs (U.S. Signatory)

The Revised Great Lakes Water Quality Agreement of 1978 is a location-specific ARAR that is relevant because of the proximity of the sites at Selfridge ANGB to Lake St. Clair. The agreement specifically addresses a contaminant pathway likely to be found at Selfridge ANGB: the transfer of contaminated groundwater to waters of the Great Lakes. Table 4-28, Potential International Chemical-Specific ARARs, lists the water quality criteria established for the Great Lakes.

Table 4-28

Potential International Chemical-Specific ARARs, IRP Stage 2, Selfridge ANGB, MI

Parameter	Great Lakes Water Quality Agreement Objective (mg/L)
A. Persistent Toxic Substances	
1. Organic	
(a) Pesticides	
Aldrin + dieldrin	1E-06
Chlordane	6E-05
DDT	3E-06
Endrin	2E-06
Heptachlor/heptachlor epoxide	1E-06
Lindane	1E-05
Methoxychlor	4E-05
Mirex	Below detection
Toxaphene	8E-06
(b) Other compounds	
Phthalic acid esters	
Dibutyl phthalate	4E-03
Bis(2-ethylhexyl) phthalate	6E-04
Other phthalic acid esters	2E-04
Other toxic, persistent compounds	Below detection
2. Inorganic	
(a) Metals	
Arsenic	5E-02
Cadmium	2E-04
Chromium	5E-02
Copper	5E-03
Iron	3E-01
Lead	2.5E-02
Mercury	2E-04
Nickel	2.5E-02
Selenium	1E-02
Zinc	3E-02

Table 4-28
(continued)

Parameter	Great Lakes Water Quality Agreement Objective (mg/L)
(b) Other inorganic substances	
Fluoride	1.2E00
Total dissolved solids	2E+02
B. Nonpersistent toxic substances	
1. Organic substances	
(a) Pesticides	
Diazinon	8E-05
Guthion	5E-06
Parathion	8E-06
Other nonpersistent pesticides	0.05 x 96-hr LD_{50} for local species
(b) Other organic substances	
Unspecified nonpersistent toxic substances and complex effluents	0.05 x 96-hr LD_{50} for local species
Oil and petrochemicals	(i) No visible film, sheen, or discoloration (ii) No detectable odor (iii) No tainting of edible aquatic organisms (iv) No formation of deposits
2. Inorganic substances	
Ammonia (NH_3)	2E-02
Total ammonia	5E-01
Hydrogen sulfide	2E-03

Table 4-28
(continued)

Parameter	Great Lakes Water Quality Agreement Objective (mg/L)
C. Other substances	
1. Dissolved oxygen	>6.0
2. pH (units)	6.5 to 9.0
3. Nutrients	
Total phosphorus	5E-01
Effluent total phosphorus	1E+00*
4. Taste and odor	
(a) Taste and odor	L.D.
(b) Phenolic compounds	1E-03
(c) Substances that taint edible organisms	<Tainting concentration

*Standard for sewage treatment plant discharge to Lake Erie.

4.4 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- SOUTHWEST LANDFILL

4.4.1 Pathway Characterization and Migration Potential -- SWLF

4.4.1.1 Subsurface Conditions -- SWLF

The predominant soil series covering the SWLF site, as mapped by the USDA Soil Survey (see Figure 2-5), is the Lamson Series. This soil series developed from the silty sand and sand deposited over the area by the Clinton River. A major portion of this soil has been removed or disturbed due to borrow pit and landfill activity at SWLF. Undisturbed Lamson Series soils are found along the perimeter of the site and as isolated remnants within the site. A strip of undisturbed soil and the underlying alluvial unit are apparently preserved at monitor well 01-156.

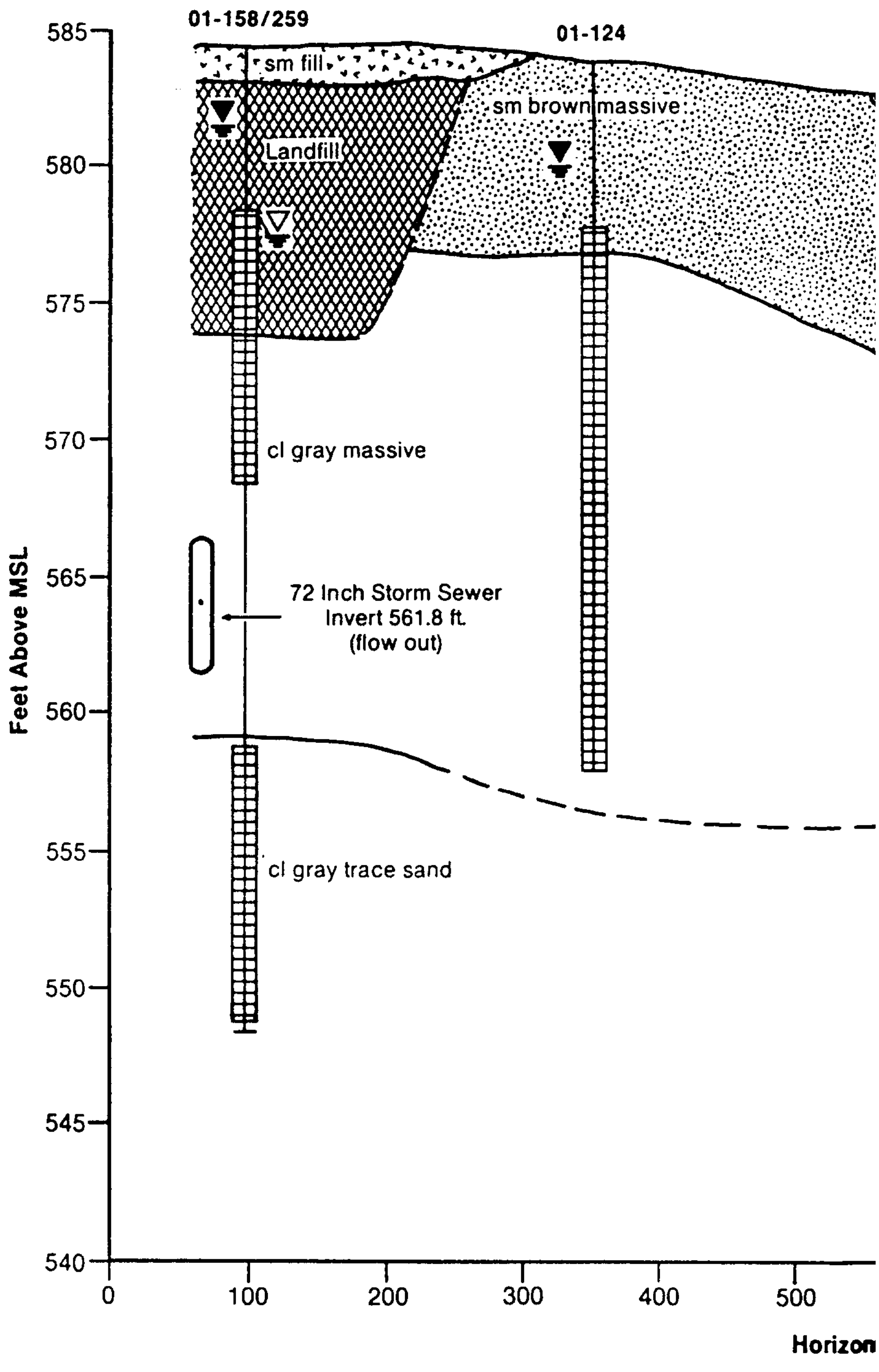
The alluvial unit at SWLF is comprised of layered sand, silt, and clay deposits. Figures 4-25, 4-26, and 4-27 are cross sections showing the thickness and lateral extent of the alluvial unit and the other sediments at the site. The trace of the cross sections is shown in Figure 4-28. The discontinuous nature of the sand is due in part to depositional processes and to its removal and use as fill material. A former borrow pit along the eastern side of the site is currently being used for landfilling of construction debris and disposal of miscellaneous equipment and appliances.

Removal of natural material has also taken place to the west of the SWLF site. Based upon an examination of aerial photographs, a series of east-west-trending trenches was dug along the drainage ditch next to the perimeter road. These trenches, approximately six in number, had natural material removed from them and were then used for disposal of solid waste. Monitor well nest 01-158/259 penetrated waste in one of these trenches.

Examination of aerial photographs and the USDA Soil Series map (see Figure 2-5) indicates that borrow pit activities also occurred in an area south of SWLF. Based upon the aerial photographs, it appears that the borrow pit was used as a landfill. Monitor well 01-125 on the southern side of SWLF is located to the north of this area.

The dominant subsurface soil type at SWLF is a gray, plastic, silty clay. The silty clay was encountered throughout the site at 10 to 15 feet BLS and extended to a depth of 35 to 36 feet (see Figure 4-26). The nature of the soils/fill overlying this silty clay varied with location. The upper 10 feet at monitor well nest 01-162/263 consisted of layered sand, silt, and clay. The upper 10 to 15 feet at monitor well nest 01-158/259 consisted of landfill waste including residential waste and construction debris. The landfill waste was composed of carpet and

West A



01-158/259
01-124
sm fill
sm brown massive
Landfill
cl gray massive
72 Inch Storm Sewer
Invert 561.8 ft.
(flow out)
cl gray trace sand
Feet Above MSL
585
580
575
570
565
560
555
550
545
540
0
100
200
300
400
500
Horizon

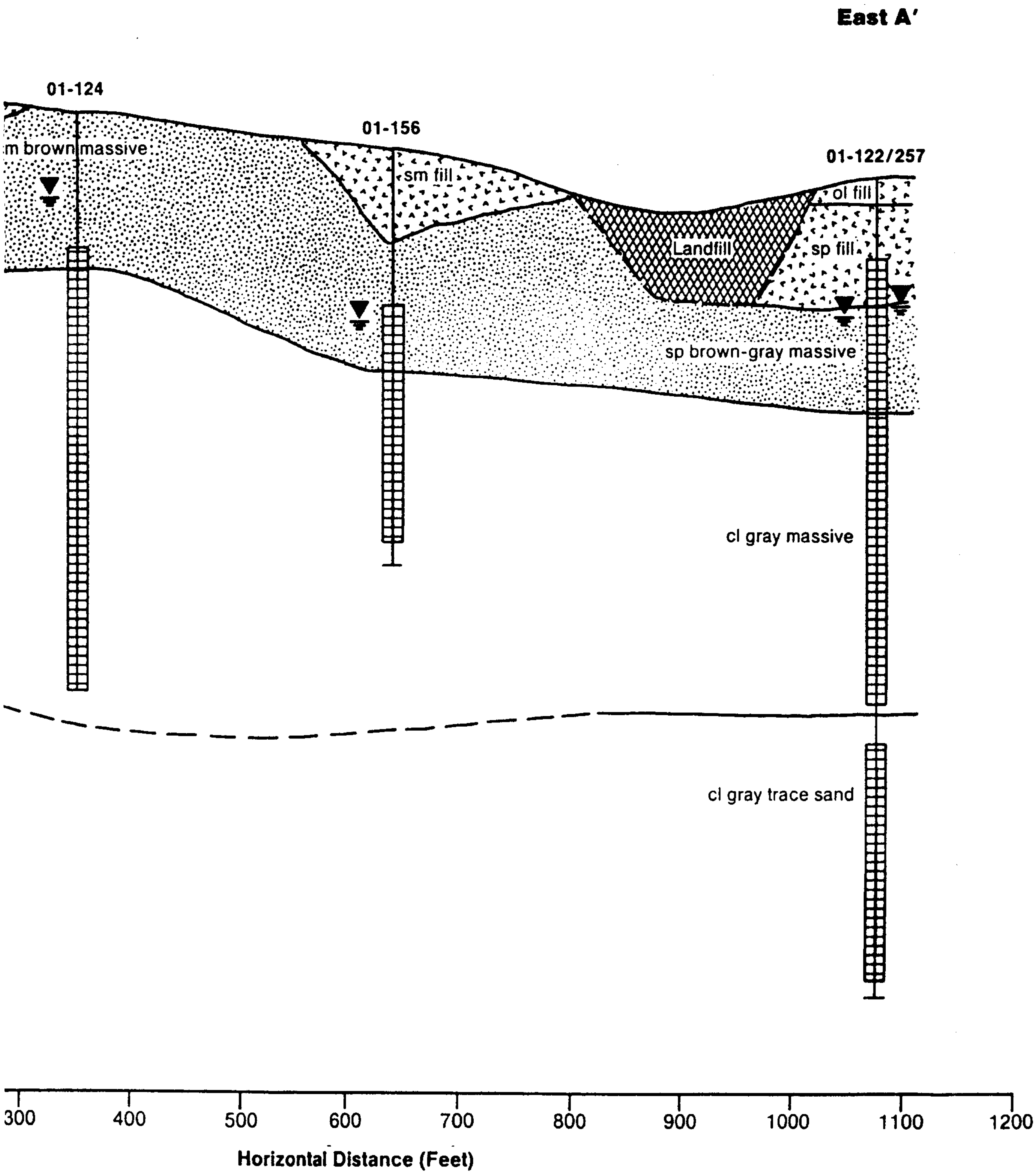


FIGURE 4-25 SWI
CRC

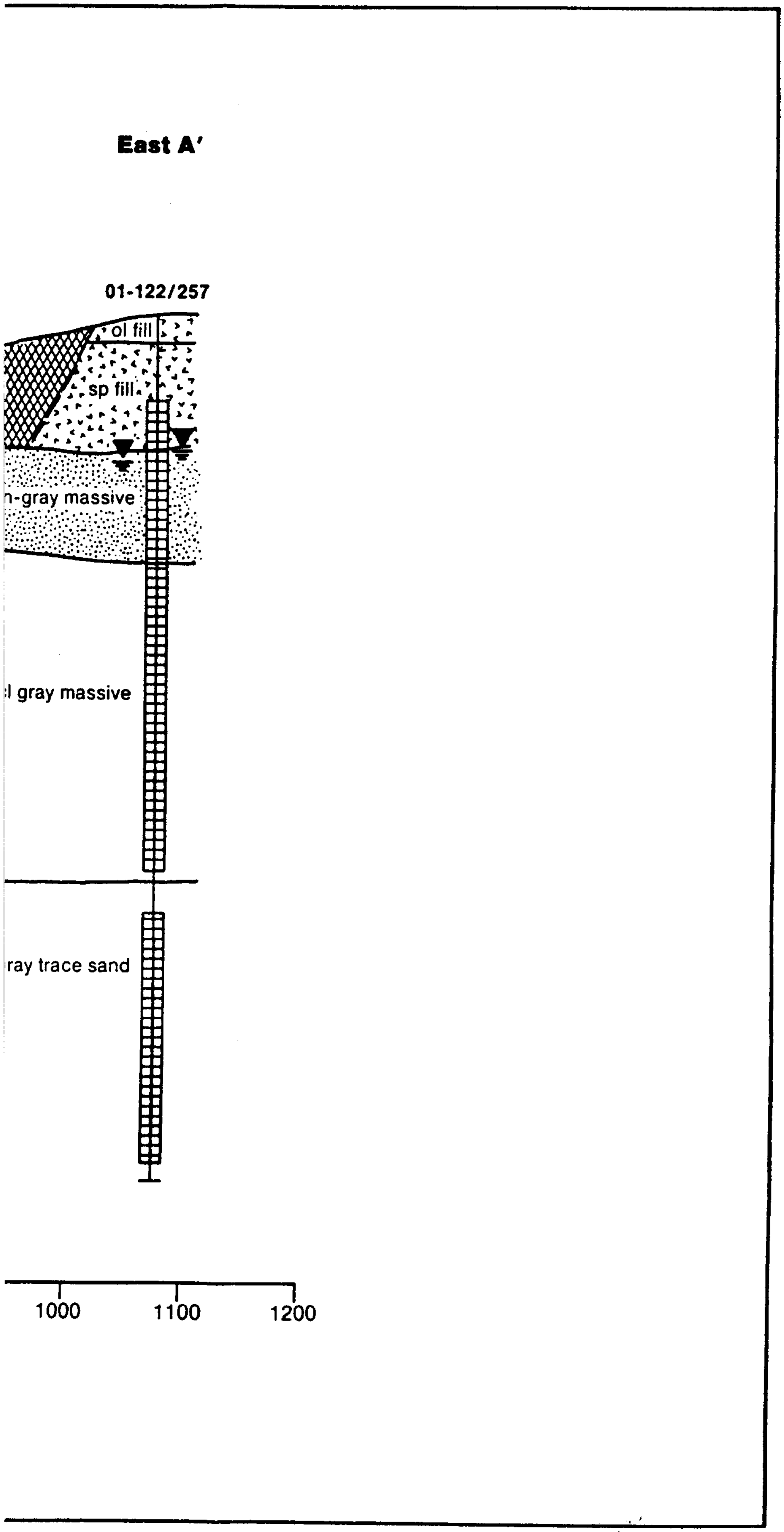


FIGURE 4-25 SWLF GEOLOGIC CROSS SECTION A-A'

Soil Classification System

Symbol	Typical Description
gm	Silty gravels, gravel-sand-silt mixture, dry to wet
gc	Clayey gravels, gravel-sand-silt mixture, dry to wet
sp	Poorly graded sands, gravelly sands, little or no fines, dry to wet, massive
sm	Silty sands, sand-silt mixtures, trace gravel, dry to wet, massive, friable to dense
sc	Clayey sands, sand-clay, dry to wet, massive, friable to wet
ml	Inorganic silts, very fine sands, silty or clayey fine sands, clayey silts, slight plasticity, massive to laminated, mottled to not mottled
cl	Inorganic clays, gravelly clays, sandy clays, silty clays, low to high plasticity, massive to laminated, mottled to not mottled
ol	Organic silts and silty clays, low plasticity, topsoil

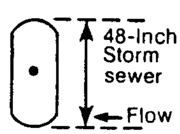
Boundary Lines

Soil unit

Suggested soil unit

Potentiometric surface at shallow monitor well on 1 August 1988

Potentiometric surface at deep monitor well on 1 August 1988



Stormwater drainage system with indicated size and flow direction

NOTE: Vertical exaggeration varies with each cross section.

Soil Unit Descriptions

Alluvial sand - Unconsolidated detrital material consisting of fine-grained sand to silty sand, deposited as channel sands or levee deposits by the ancestral Clinton River

Beach sand - Unconsolidated detrital material consisting of massive medium-to fine-grained sand with some silt, deposited at a former shoreline of ancestral Lake St. Clair

Lacustrine clay - Unconsolidated detrital material comprised of two units: Upper unit consists of rusty-brown to light brown, stiff clay to silty clay, with brown and reddish mottles, minor admixtures of sand, and some organic material; Lower unit consists of olive-gray to dark gray, plastic clay to silty clay with gray mottles

Till - Unconsolidated to semiconsolidated glacial material comprised of two units: Upper unit consists of a sand-clay layer with a local thin lens of coarse sand and gravel; lower unit consists of a dense sand and silt

Fill material - Manmade deposits of natural materials, clay, silt, and sand used to raise the surface of low-lying land

Landfill waste - Sanitary waste and construction debris disposed by placing in a pit excavated in the ground

NOTE: Topsoil and coal displayed near the top of the cross section are left blank and are designated as such where found.

Monitor Well Diagrams

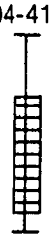
04-412

Soil boring

04-152/253

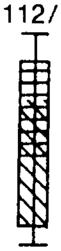
Nested monitor well pair (shallow/deep) with screens

04-411



Shallow monitor well with screen

04-112/249



Nested monitor well pair with overlapping screens for Phase II Stage 1 and Stage 2 monitor wells

FIGURE 4-25 (Continued) LEGEND FOR ALL CROSS SECTIONS PRESENTED IN SECTION 4

sting of fine-grained sand to silty
by the ancestral Clinton River

ting of massive medium-to fine-
reline of ancestral Lake St. Clair

mprised of two units: Upper unit
lty clay, with brown and reddish
material; Lower unit consists of
gray mottles

aterial comprised of two units:
l thin lens of coarse sand and

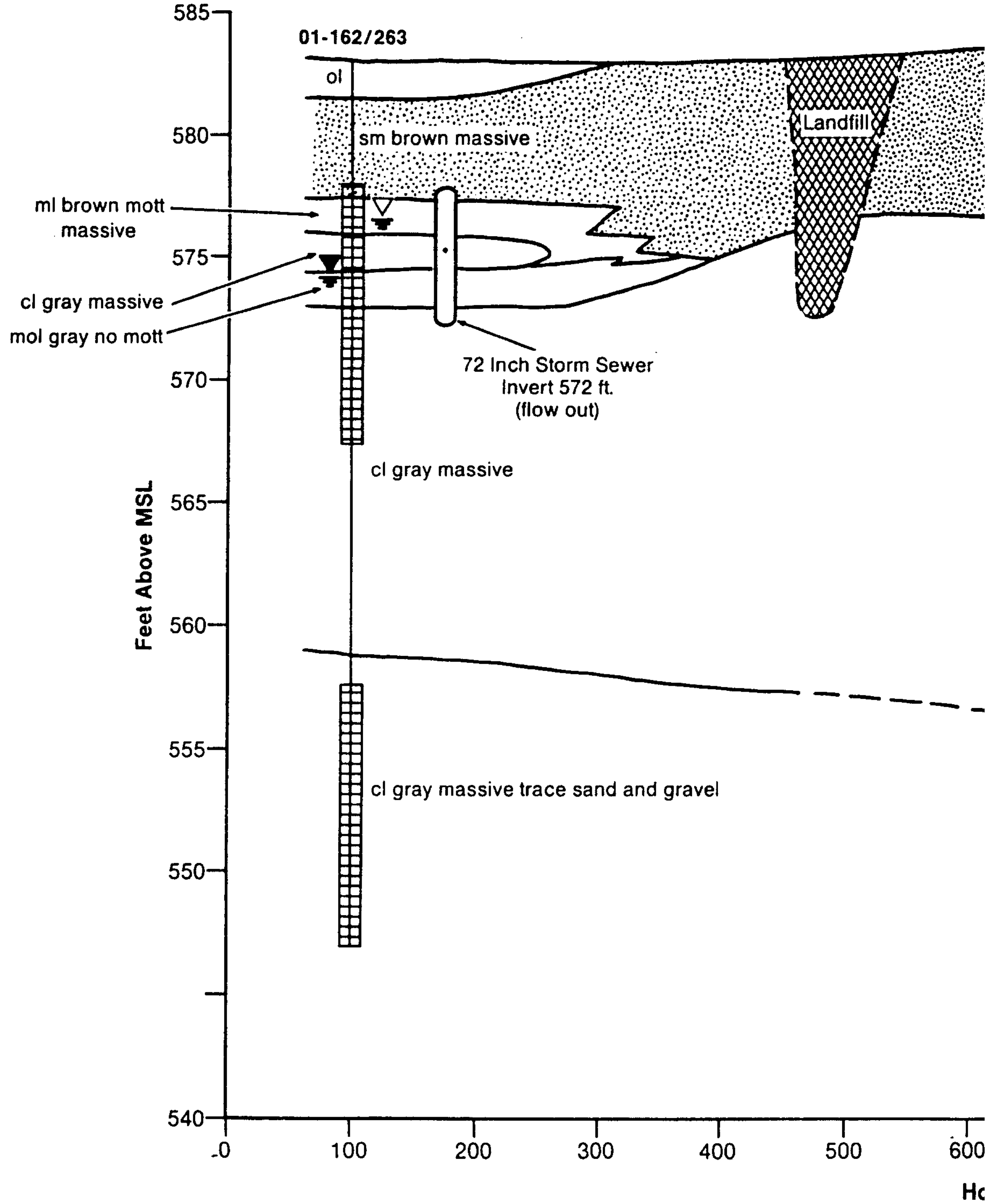
clay, silt, and sand used to raise

ris disposed by placing in a pit

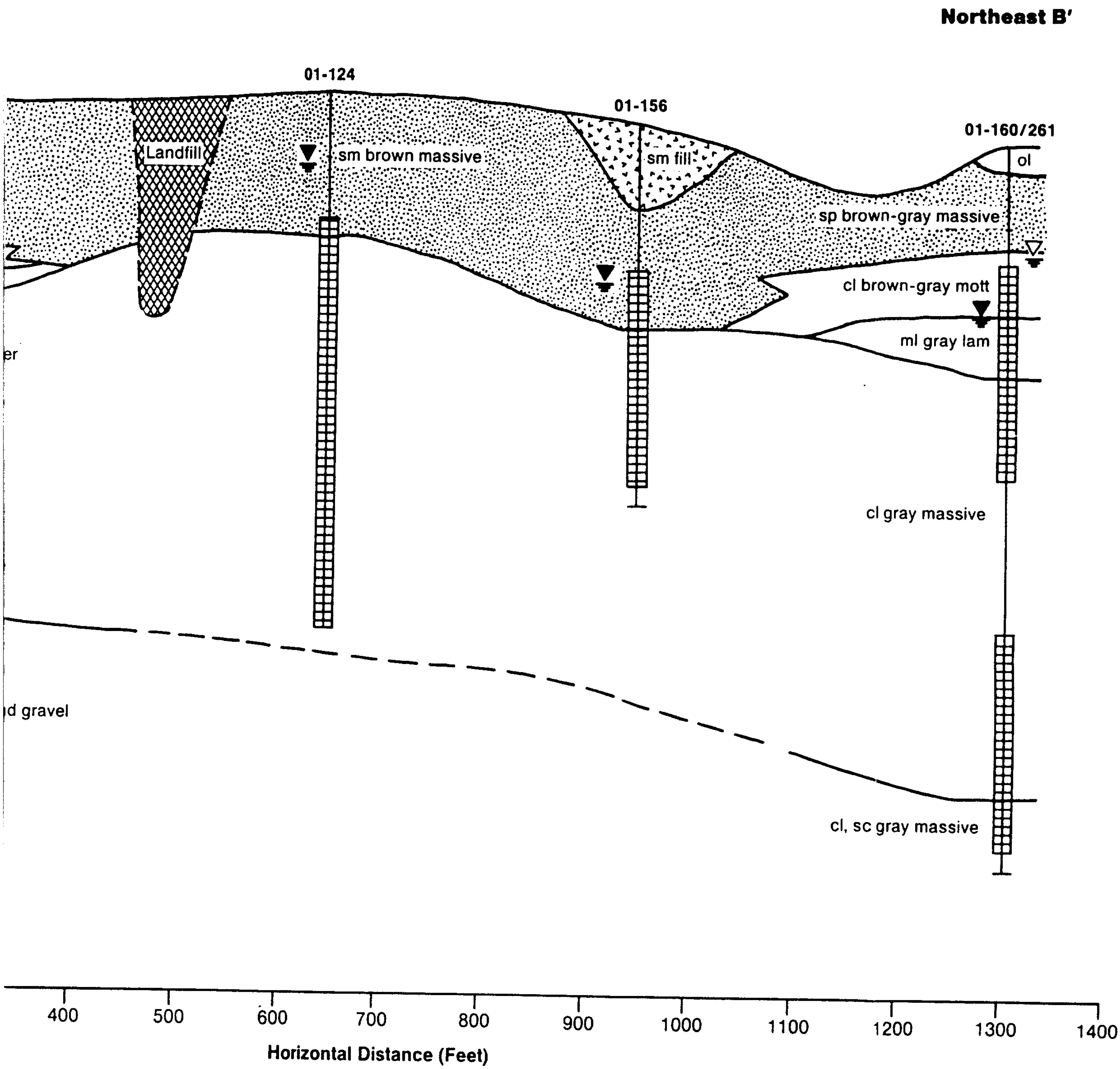
cross section are left blank and

FIGURE 4-25 (Continued) LEGEND FOR ALL CROSS SECTIONS PRESENTED IN SECTION 4

Southwest B



01-162/263
ol
sm brown massive
Landfill
ml brown mott massive
cl gray massive
mol gray no mott
72 Inch Storm Sewer Invert 572 ft. (flow out)
cl gray massive
cl gray massive trace sand and gravel
Feet Above MSL
585
580
575
570
565
560
555
550
540
0
100
200
300
400
500
600
Ho



Northeast B′
01-124
01-156
01-160/261
Landfill
sm brown massive
sm fill
ol
sp brown-gray massive
cl brown-gray mott
ml gray lam
er
cl gray massive
d gravel
cl, sc gray massive
400
500
600
700
800
900
1000
1100
1200
1300
1400
Horizontal Distance (Feet)

FIGURE 4-26

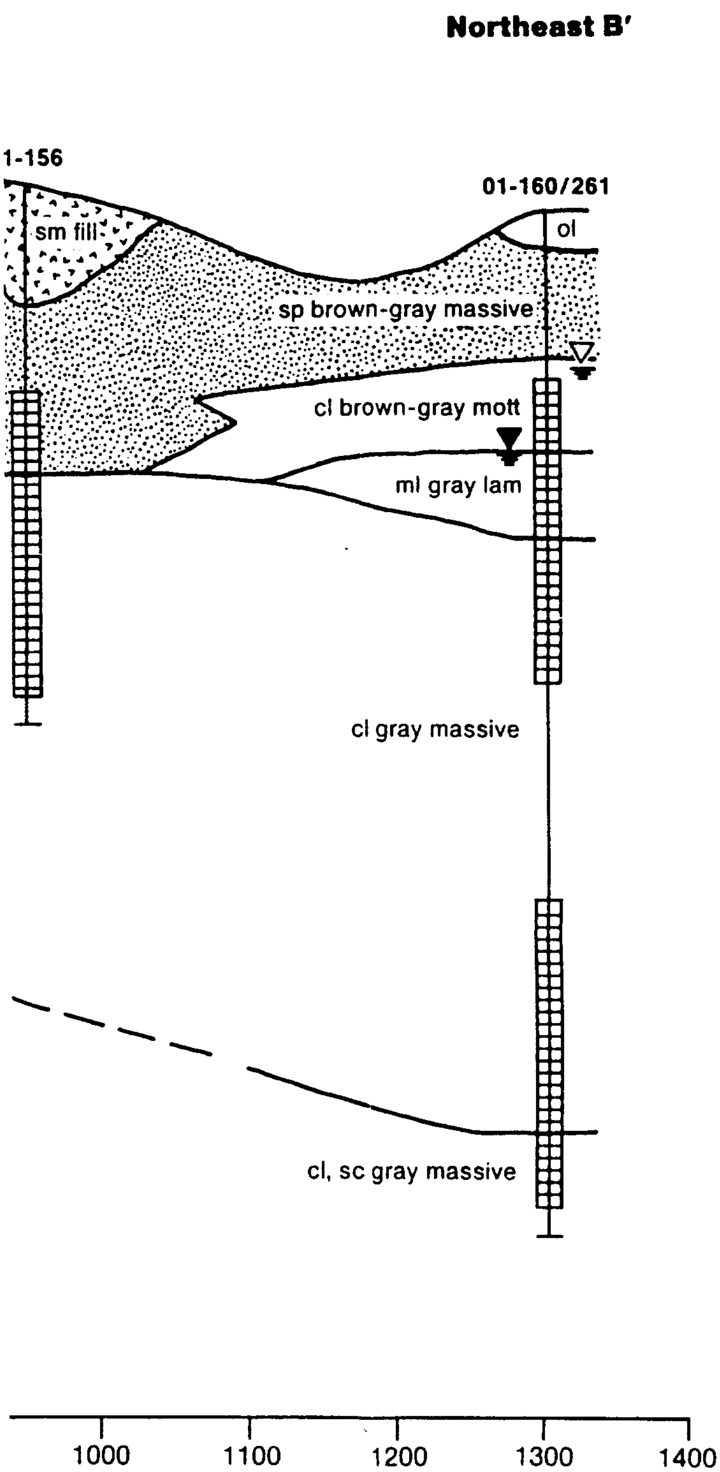
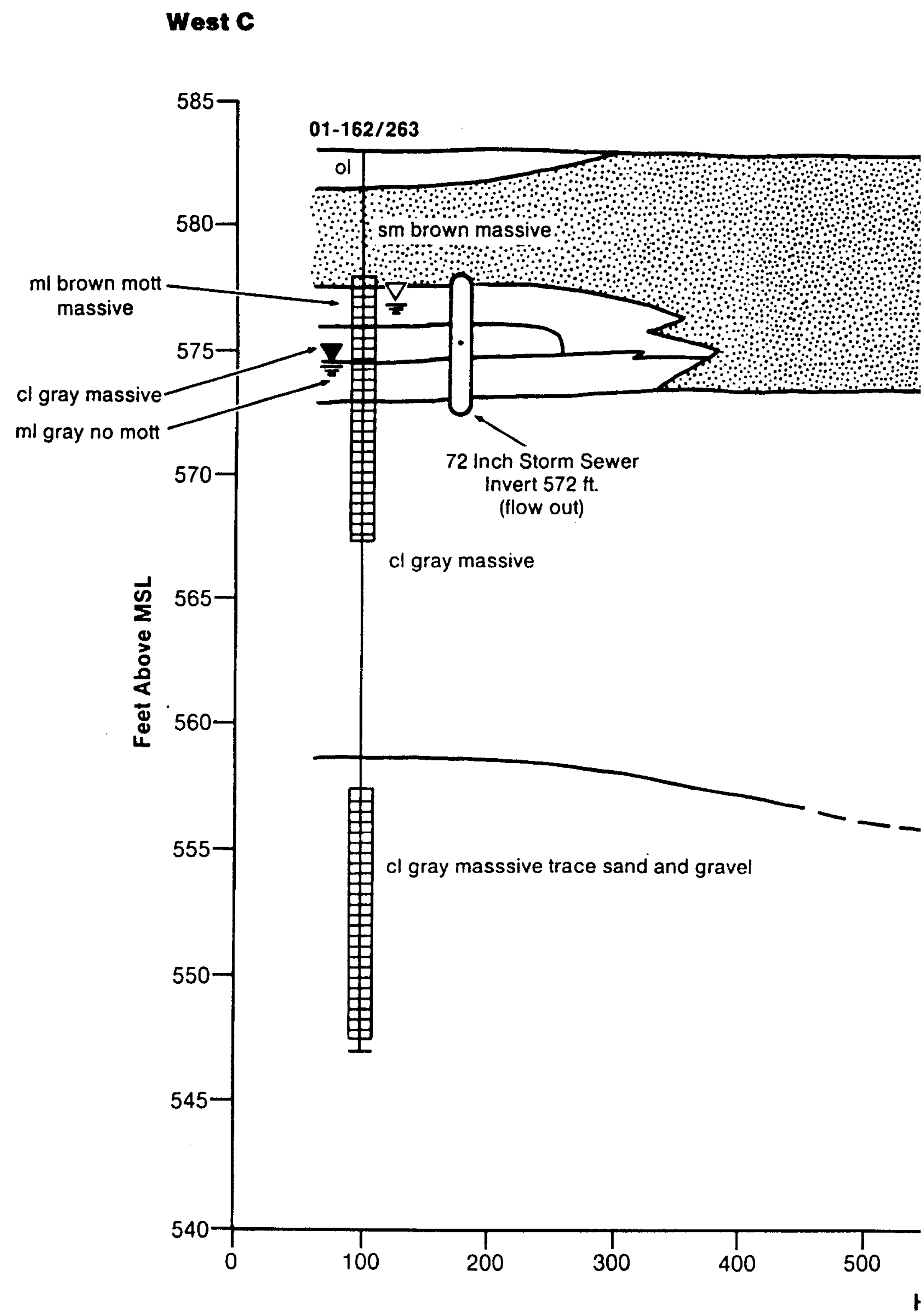
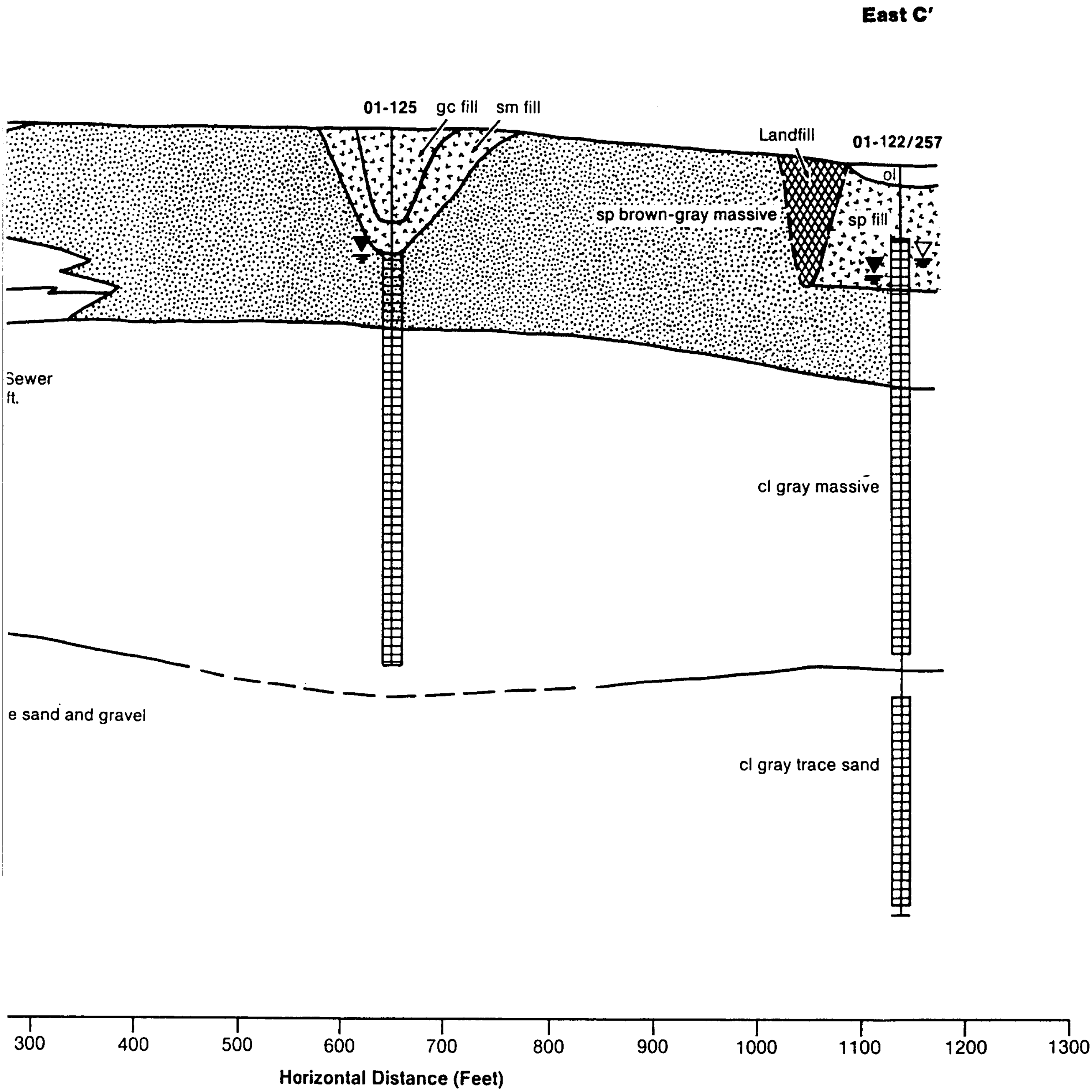


FIGURE 4-26 SWLF GEOLOGIC CROSS SECTION B-B'


West C
01-162/263
ol
sm brown massive
ml brown mott massive
cl gray massive
ml gray no mott
72 Inch Storm Sewer Invert 572 ft. (flow out)
cl gray massive
cl gray masssive trace sand and gravel
Feet Above MSL
585
580
575
570
565
560
555
550
545
540
0
100
200
300
400
500



East C'
01-125
gc fill
sm fill
Landfill
01-122/257
ol
sp brown-gray massive
sp fill
Sewer
ft.
cl gray massive
e sand and gravel
cl gray trace sand
300
400
500
600
700
800
900
1000
1100
1200
1300
Horizontal Distance (Feet)

FIGURE 4-27

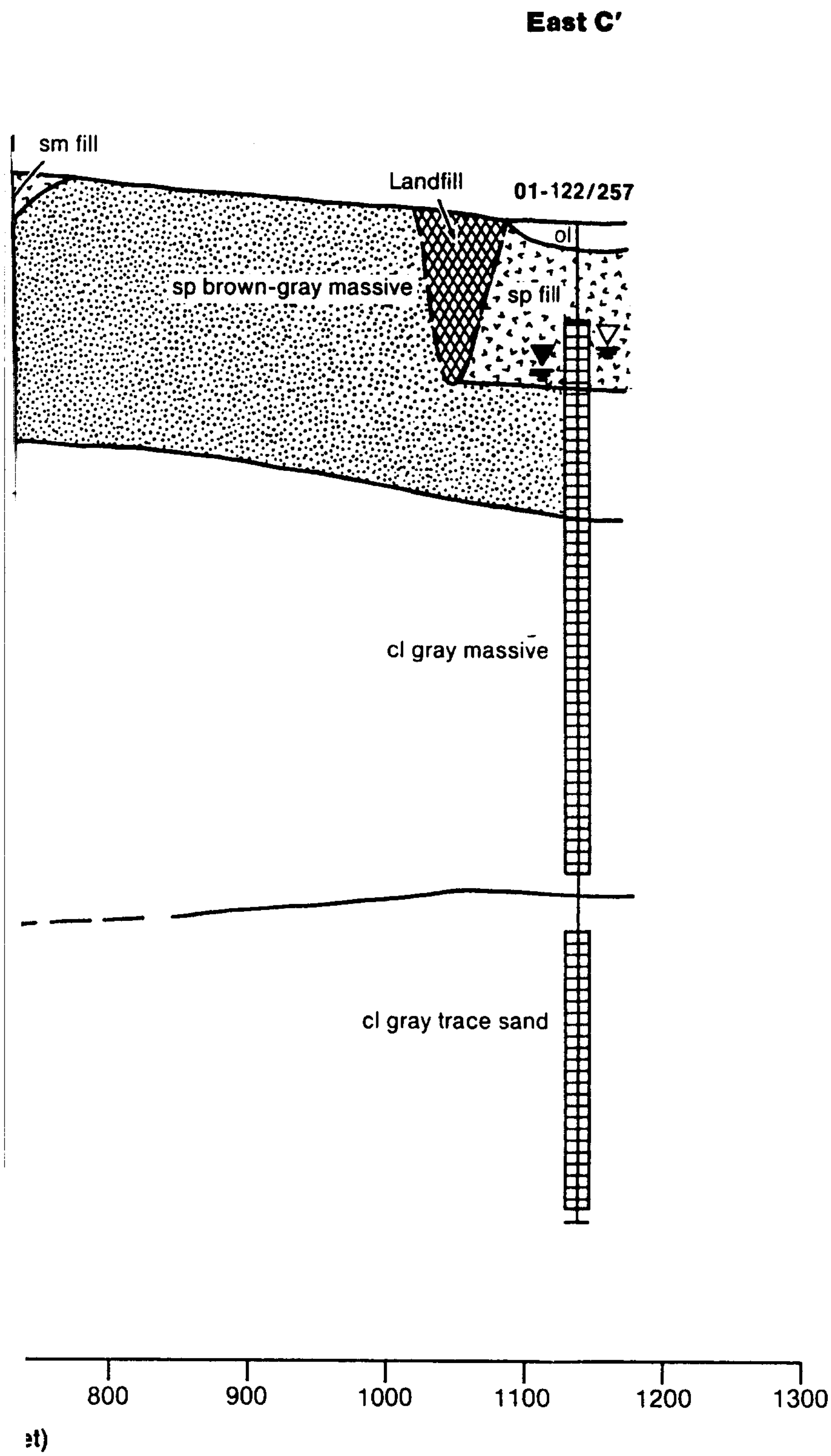
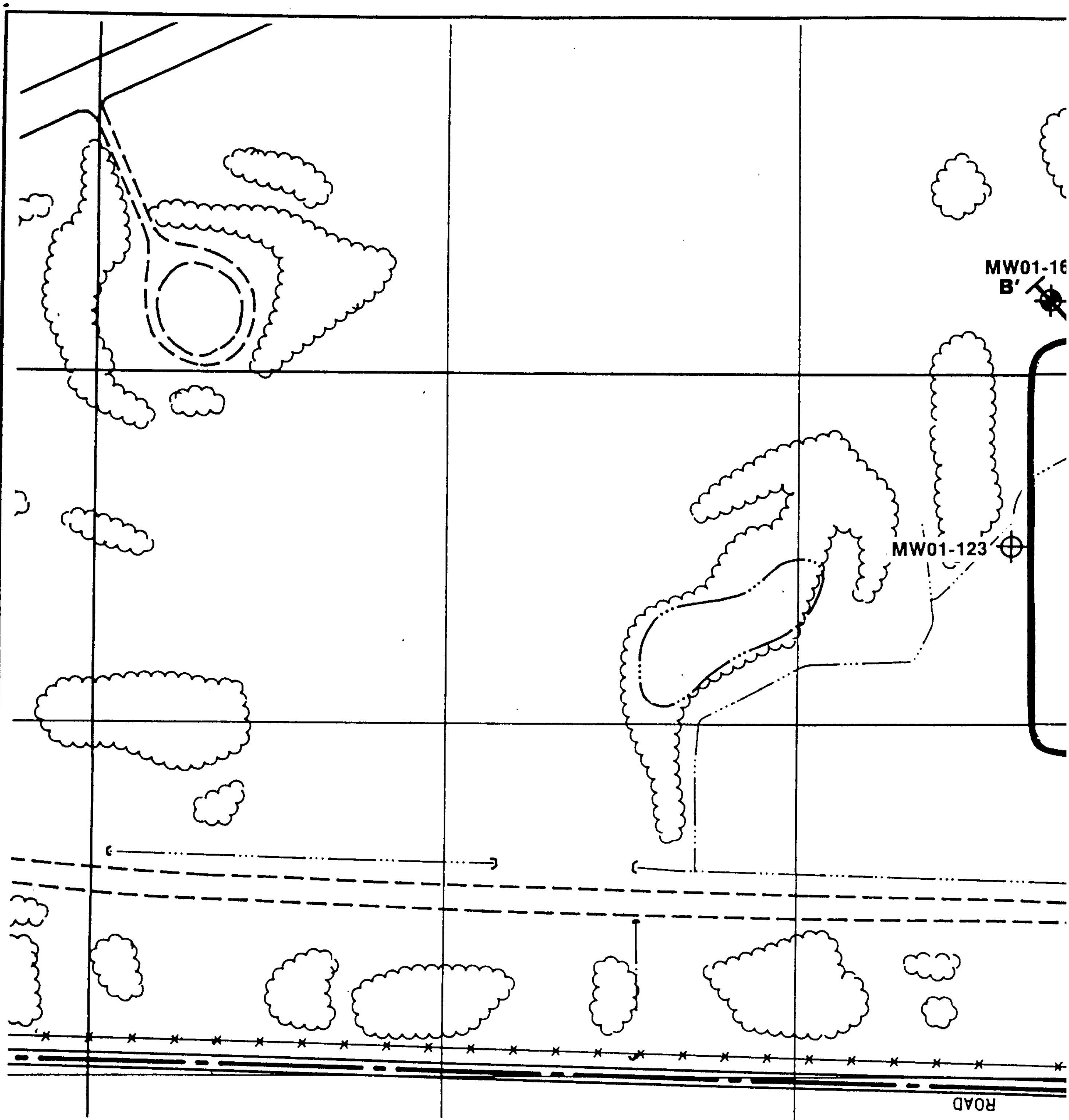


FIGURE 4-27 SWLF GEOLOGIC CROSS SECTION C-C'



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

0 100 200 400

Scale in Feet

Legend

Site Boundary

MW01-158/259 Nested Well Pair (Deep and Shallow)

MW01-156 Shallow Well

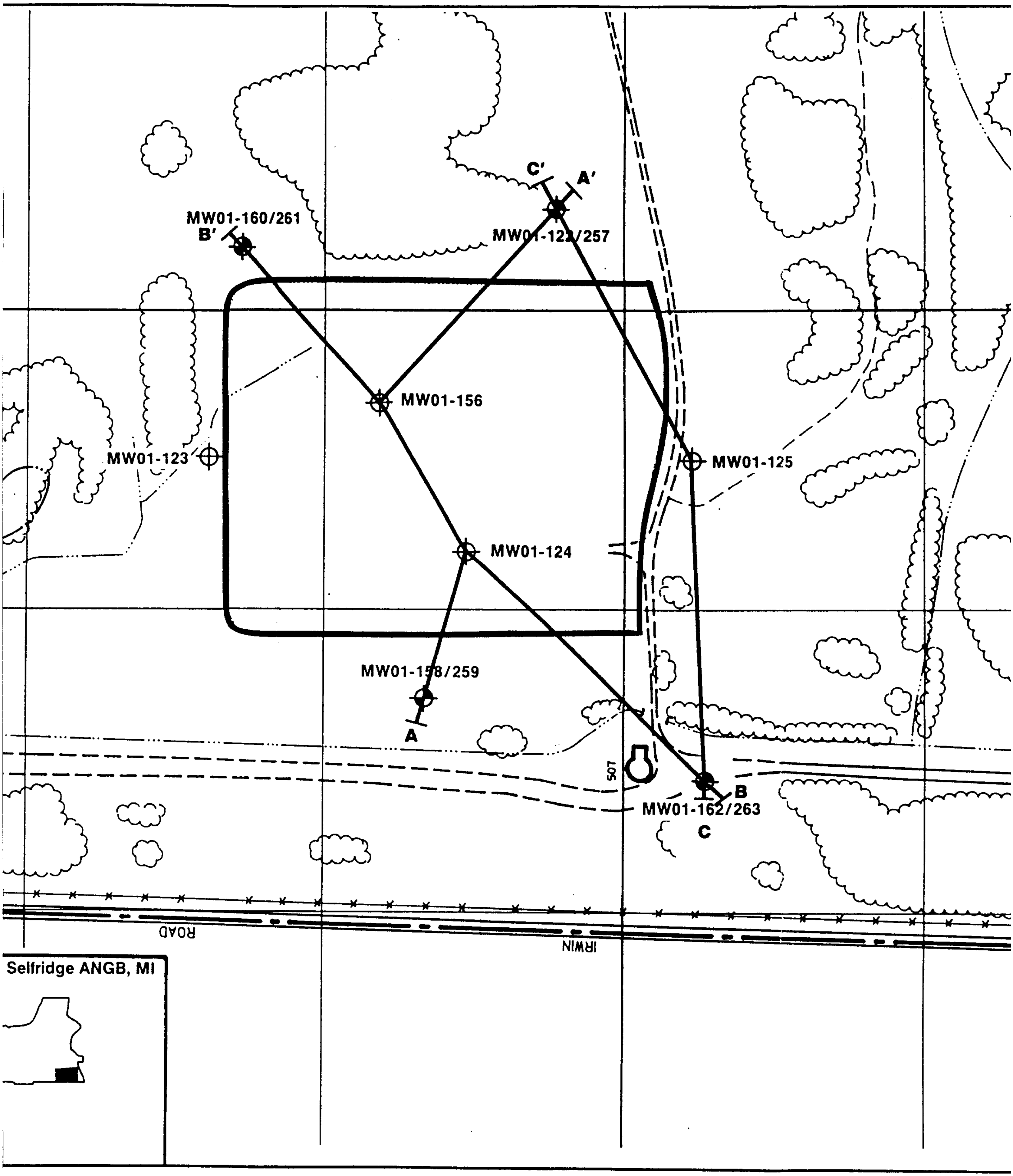


FIGURE 4-28 TRA
A-A'
AT S

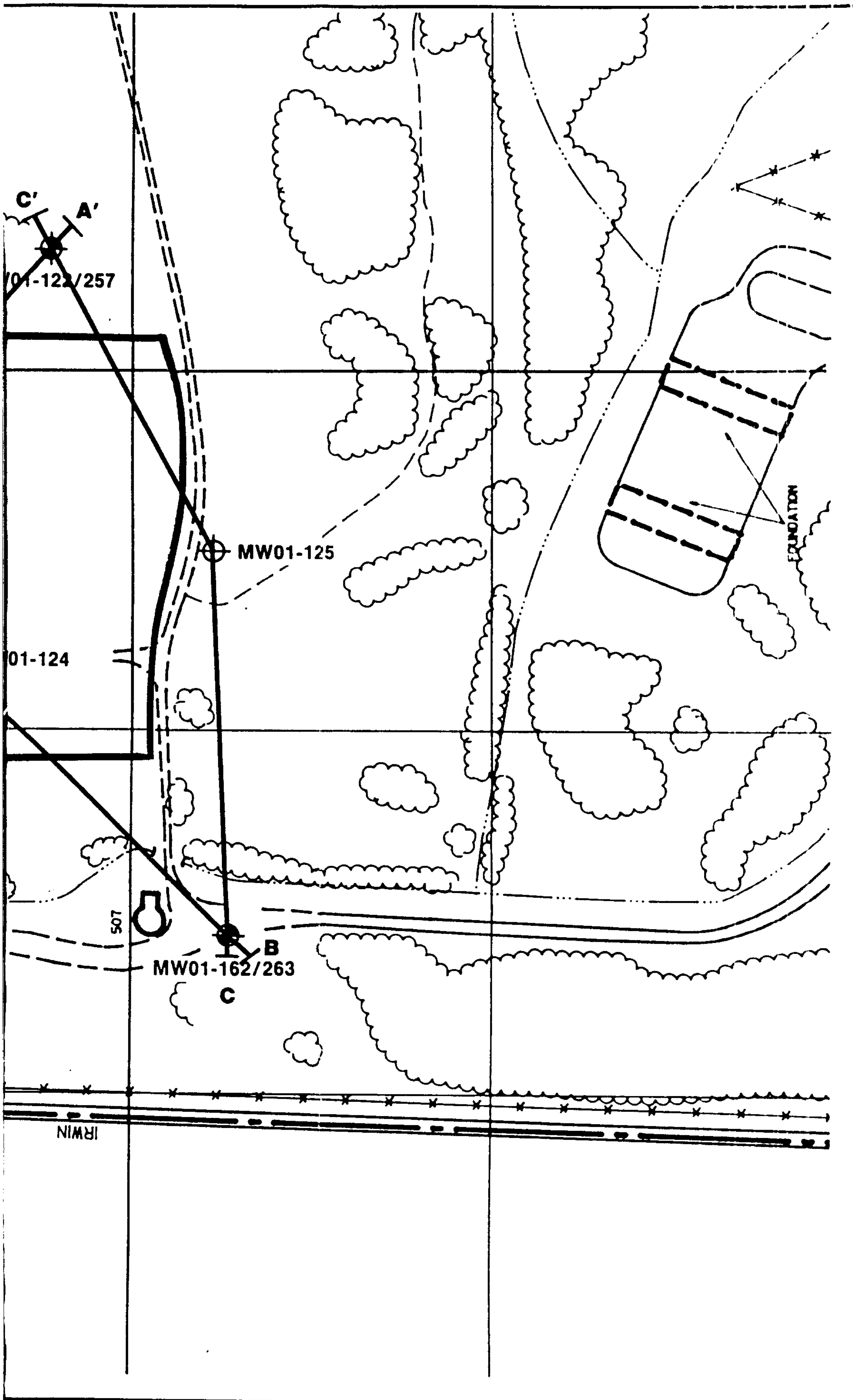


FIGURE 4-28 TRACE OF CROSS SECTIONS A-A', B-B', AND C-C' AT SWLF

wood scraps, plastic and rubber fragments, and other miscellaneous debris mixed within a clay matrix. Five to 10 feet of well-sorted, brown, sandy silt was encountered in the uppermost portion of the borehole for shallow monitor well 01-156. Although this monitor well was located in the approximate center of the SWLF site, the soil materials appeared to be natural, in situ, alluvial sediment. A similar silt deposit was observed between 0.5 and 3 feet BLS in the borings for monitor well nest 01-160/261. Laminated, brown-gray clay and silt were present from 5 to 10.5 feet at monitor well nest 01-160/261 (the 3- to 5-foot interval was not recovered in either borehole). This monitor well nest was located outside SWLF along the northeastern boundary of the site.

The total volatile organic (TVO) content of soil samples from the soil and monitor well borings was determined using an organic vapor analyzer (OVA). Background OVA readings at SWLF were 1 unit, except in the vicinity of monitor well nest 01-158/259. OVA readings of 2 to 3 units were obtained at this location.

Soil samples from the following monitor well borings at SWLF registered OVA readings above background level: 01-156, 01-158, 01-259, 01-261, and 01-263. The highest OVA readings for soil samples taken at SWLF were recorded from samples obtained from deep monitor wells 01-259 and 01-261. OVA measurements of soil cores taken from monitor well 01-259 ranged from 1 to 200 units; the highest OVA reading was obtained from the 25- to 30-foot interval, which registered 50 to 200 units. OVA readings of soil cores from below 5 feet in monitor well 01-261 ranged from 5 to 200 units; the highest reading was 80 to 200 units in the 30- to 35-foot interval. Soil samples from below 17 feet in monitor well 01-263 measured 0.5 to 30 units. The maximum OVA readings from soil samples taken from monitor well 01-156 were 10 to 12 units between 5 and 15 feet. Split-spoon samples taken from monitor well 01-158 registered 10 to 50 units between the 0- and 15-foot intervals. Samples of sediment from monitor wells 01-162 and 01-160 did not register OVA readings above background level.

Vapors venting from the open borehole during drilling at monitor well location 01-158 registered greater than 1,000 units. Lower explosive limit (LEL) readings above 20 percent halted work activity at this monitor well between depths of 2 and 12 feet BLS. The borehole was allowed to vent overnight, and drilling was resumed on this boring the following day when the LEL readings were within the acceptable range.

Methane produced by naturally decaying organic matter contained in the sediments is believed to be responsible for many of the elevated OVA readings obtained from soil samples at SWLF and at the other IRP sites investigated at Selfridge ANGB. Samples registering elevated OVA readings often did not register any

response on the photoionization detector (PID), which does not detect methane. However, during much of the drilling activity, the PID was inoperable due to cold weather, and therefore, PID data and OVA data cannot be compared for many of the samples taken.

Visible signs of potential subsurface contamination during drilling at SWLF were limited to monitor well nest 01-158/259. Gray clay mixed with the waste material in this interval displayed a greasy appearance. The waste material consisted of plastic, rope, wire, wood, and cloth. A strong, sewage-like odor was also detected during the advancement of these boreholes through the upper 15 feet of material.

4.4.1.2 Extent and Character of Unsaturated Zone -- SWLF

Based upon monitor well borings installed during the IRP Stage 2 study, the unsaturated zone ranges from 1 to 14 feet in thickness. Unsaturated conditions at monitor well 01-156 and 01-158/259 were only encountered above a depth of 1 to 2 feet BLS. Material comprising the unsaturated zone consisted of alluvial silty sand to sandy silt. Due to the sandy nature of the unsaturated zone, it is likely that the zone is better drained. In the vicinity of monitor wells 01-257, 01-160/261, and 01-162/263 a thicker unsaturated zone was encountered, ranging from 11 to 14 feet thick. At monitor well 01-257 an 8.5-foot alluvial sand layer was penetrated by the boring, and saturated conditions occurred at 6 feet BLS.

The unsaturated zone is comprised of both fill material and natural sediments. Fill material comprises the bulk of the sediment found within the SWLF unsaturated zone (see Figures 4-25 through 4-27). Several feet of sandy silty fill was logged at monitor well boring 01-156. Natural sediments in the unsaturated zone were determined to consist of interlayered alluvial deposits. The alluvial material was an admixture of sand, silt, and clay as described previously.

4.4.1.3 Groundwater Conditions -- SWLF

The shallow monitor wells at the SWLF site are screened in the sand and silty clay. Monitor well 01-158 is screened in landfill material, as seen in Figure 4-25. Deep monitor wells are screened totally in the silty clays underlying the alluvial deposits.

The deep monitor wells at SWLF were installed at depths ranging between 35 and 37 feet. Ten-foot well screens were positioned within a gray silty clay interval. The shallow monitor wells at SWLF were installed at depths ranging between 15 and 18 feet. These monitor wells also have 10-foot screens. Shallow monitor well 01-156 was screened in brown sandy silt. Shallow monitor well 01-160 was screened in an interlayered silt and

clay and the underlying gray clay to silty clay. Shallow monitor well 01-162 was screened in brown sand and the underlying gray clay to silty clay. Shallow monitor well 01-158 was screened in residential waste material and the underlying natural gray clay to silty clay. Saturated conditions were first encountered between 10 and 15 feet BLS. At monitor well 01-257 saturated conditions were present between 5 and 10 feet.

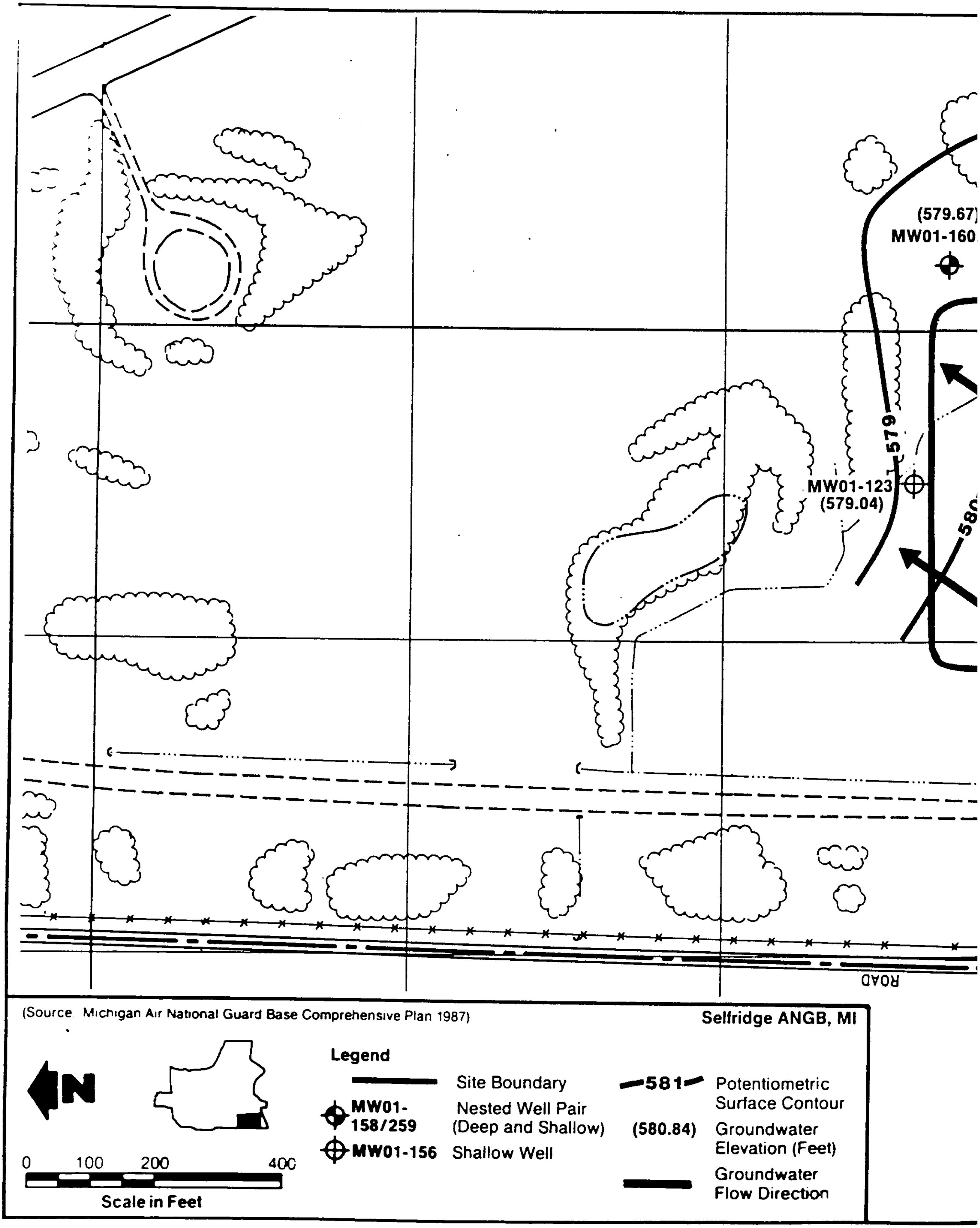
Water level measurements were taken in monitor wells at seven different times between 1 February and 1 August 1988 during the IRP Stage 2 study. During this period groundwater flow at SWLF was generally in an arc to the northeast-southeast and east for shallow and deep monitor wells, respectively. These flow directions are observed for measurements taken between March and August 1988. Water level measurements in monitor wells prior to March 1988 were not used to construct potentiometric maps because equilibrium conditions had not been established.

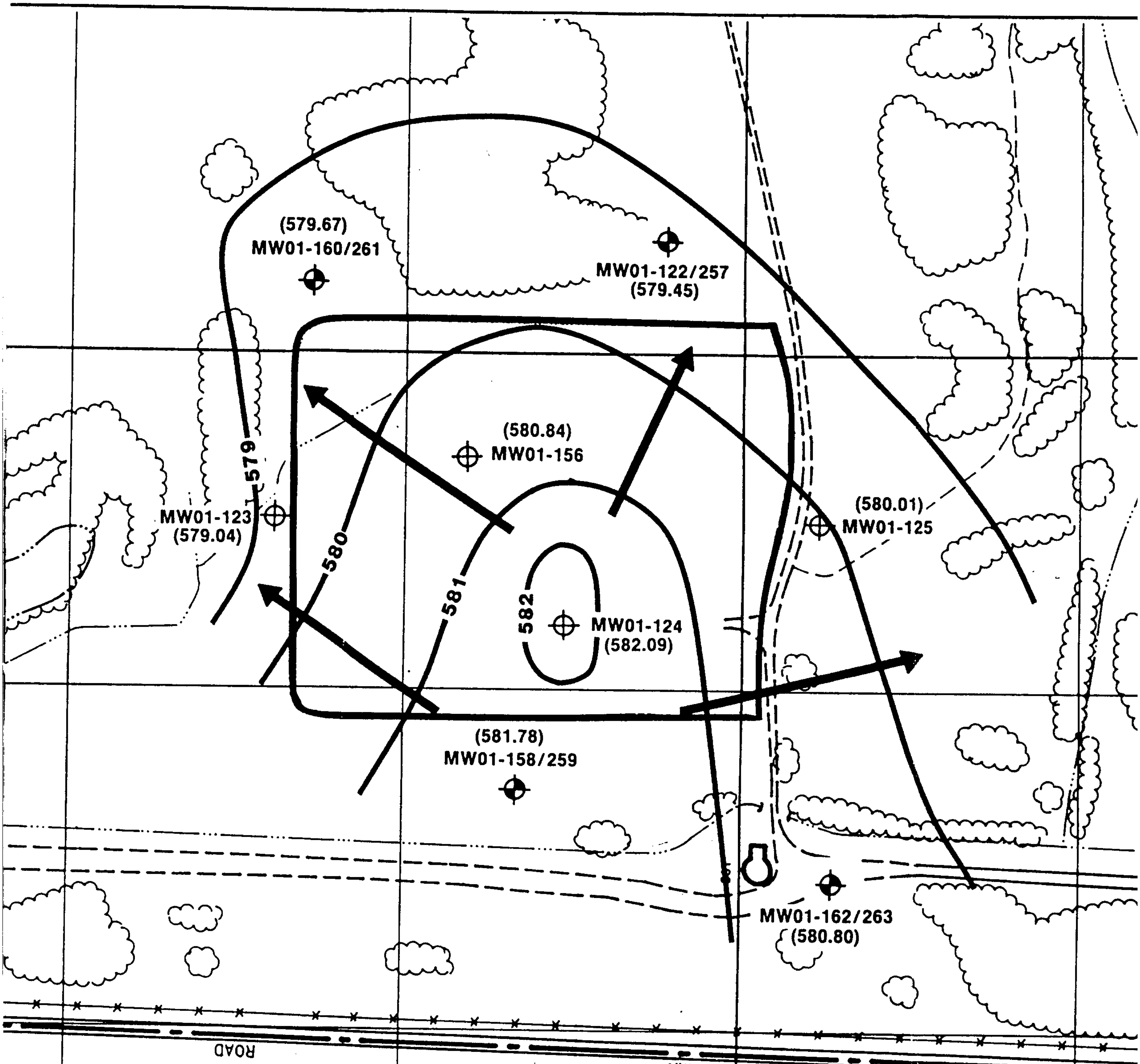
Groundwater flow in the shallow monitor wells is toward the east on 21 March 1988, as seen in Figure 4-29. Figure 4-30 is the potentiometric surface map for 1 August 1988. During this period groundwater flow was more to the east and south. A groundwater high was observed in the vicinity of monitor wells 01-158 and 01-124.

The direction of groundwater flow, based upon water level measurements taken in the deep monitor wells, was to the east and southeast on 21 March and 1 August 1988. Potentiometric surface maps are shown in Figures 4-31 and 4-32. During this period the groundwater flow direction shifted slightly from an easterly direction to a somewhat more southeasterly direction. Water levels in the monitor wells remained relatively constant during the IRP Stage 2 study. Due to the flat gradients on the potentiometric surface for each measurement period, small changes in water levels would result in changes in groundwater flow direction.

Horizontal groundwater gradients for the shallow monitor wells increased from 0.004 feet per foot (ft/ft) on 21 March to 0.01 ft/ft on 1 August 1988. The increase in steepness of the gradient can be attributed to seasonal changes in water levels. Drier conditions in the summer and less frequent rainfall resulting in decreased infiltration are the reasons for this increase in gradient. The result is that discharge of groundwater from the site occurs at a greater rate than recharge. The gradient in the deep wells remained relatively constant during this same period. A gradient of 0.001 ft/ft and 0.002 ft/ft was determined using water level data from the deep monitor wells for 21 March and 1 August 1988, respectively.

Hydraulic conductivity (K) values determined for monitor wells at SWLF range from 2.90×10^{-5} to 5.66×10^{-8} ft/sec (8.85


(579.67)
MW01-160
579
MW01-123
(579.04)
ROAD
(Source Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0 100 200 400
Scale in Feet
Legend
Site Boundary
MW01-158/259 Nested Well Pair (Deep and Shallow)
MW01-156 Shallow Well
581 Potentiometric Surface Contour
(580.84) Groundwater Elevation (Feet)
Groundwater Flow Direction



Selfridge ANGB, MI

- 81 — Potentiometric Surface Contour
- .84) Groundwater Elevation (Feet)
- Groundwater Flow Direction

FIGURE 4-29 SWL MAP WEL

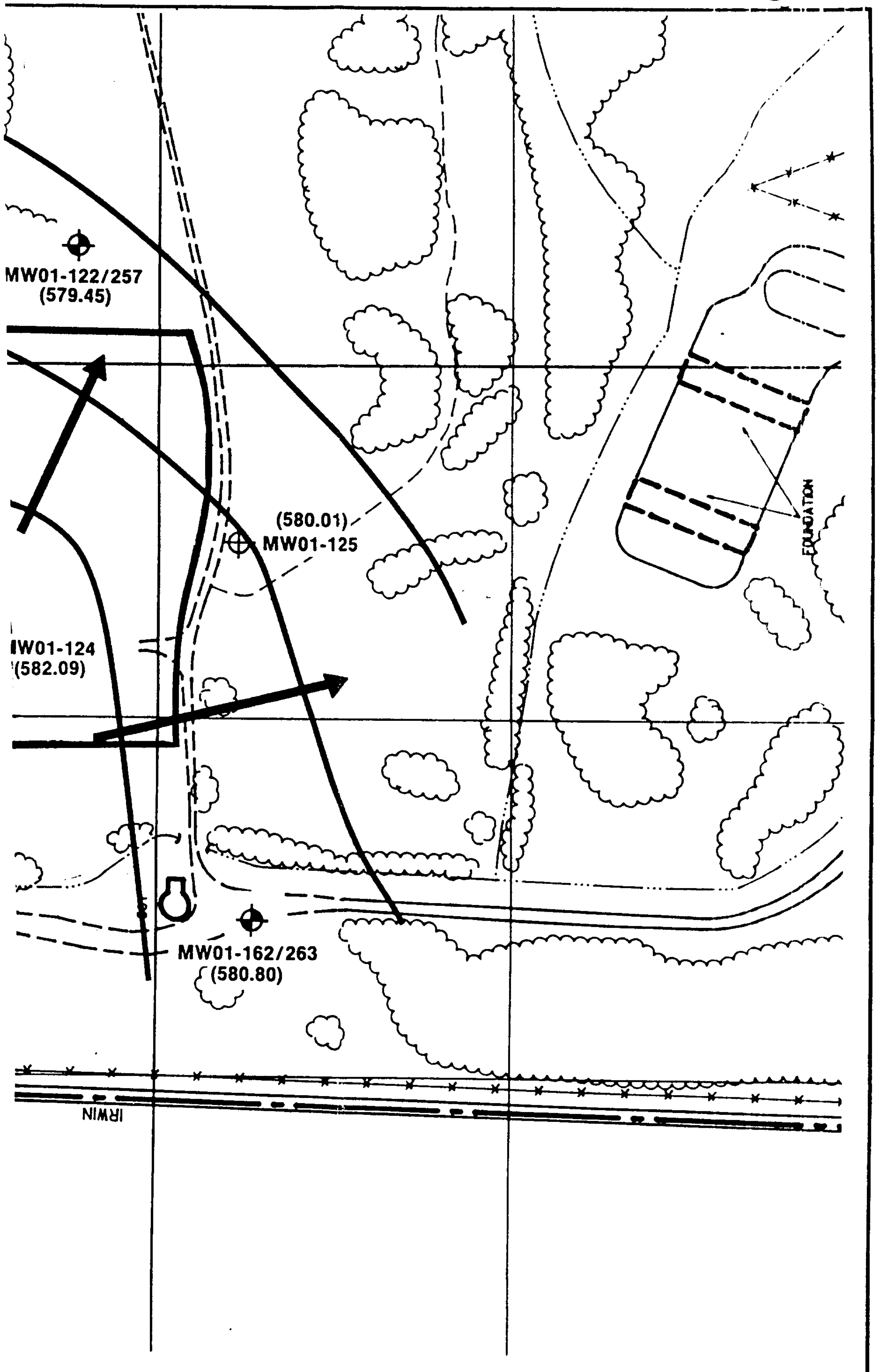
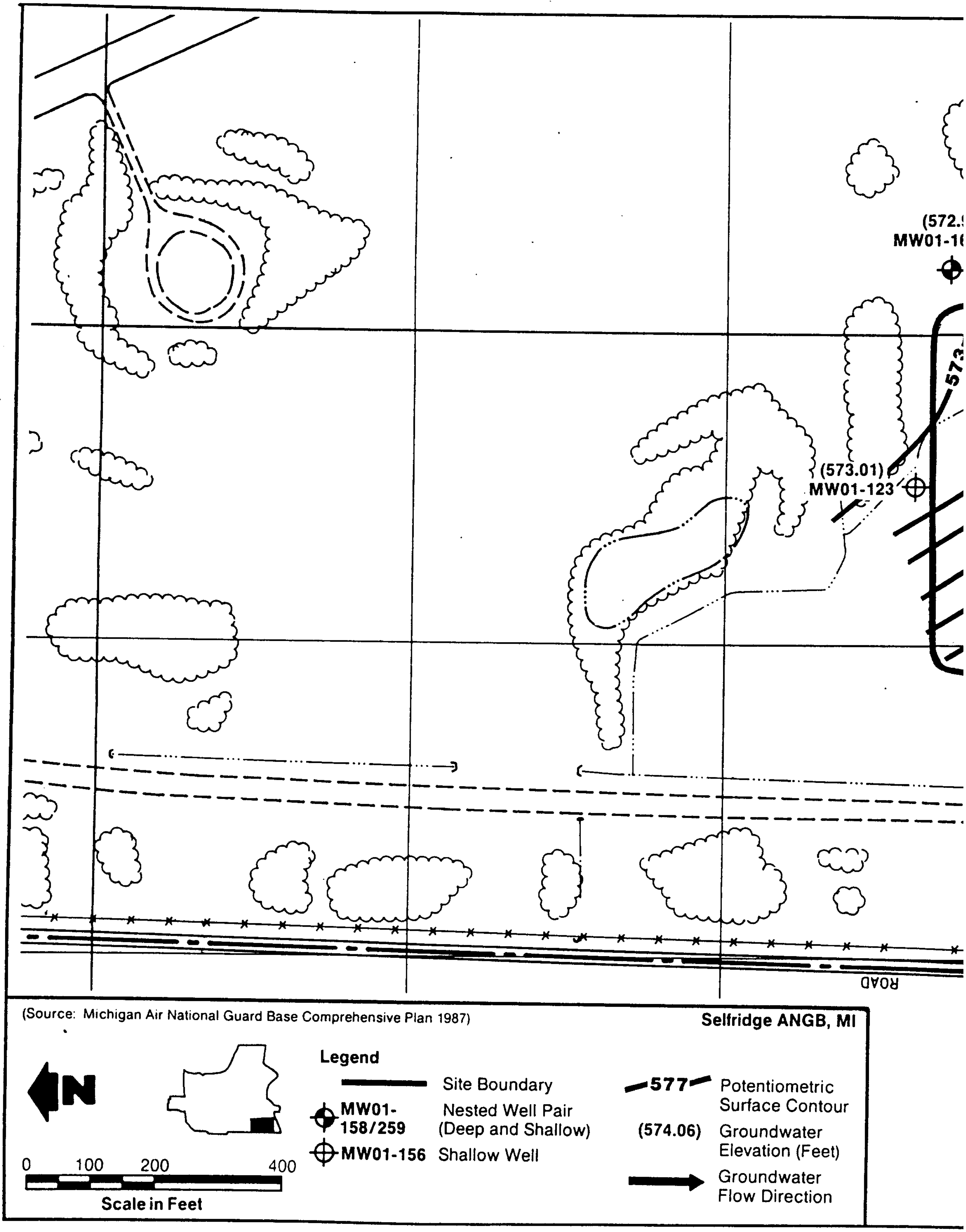


FIGURE 4-29 SWLF POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 21 MARCH 1988



(573.01)
MW01-123
ROAD
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0
100
200
400
Scale in Feet
Legend
Site Boundary
MW01-158/259
Nested Well Pair (Deep and Shallow)
MW01-156
Shallow Well
577
Potentiometric Surface Contour
(574.06)
Groundwater Elevation (Feet)
Groundwater Flow Direction

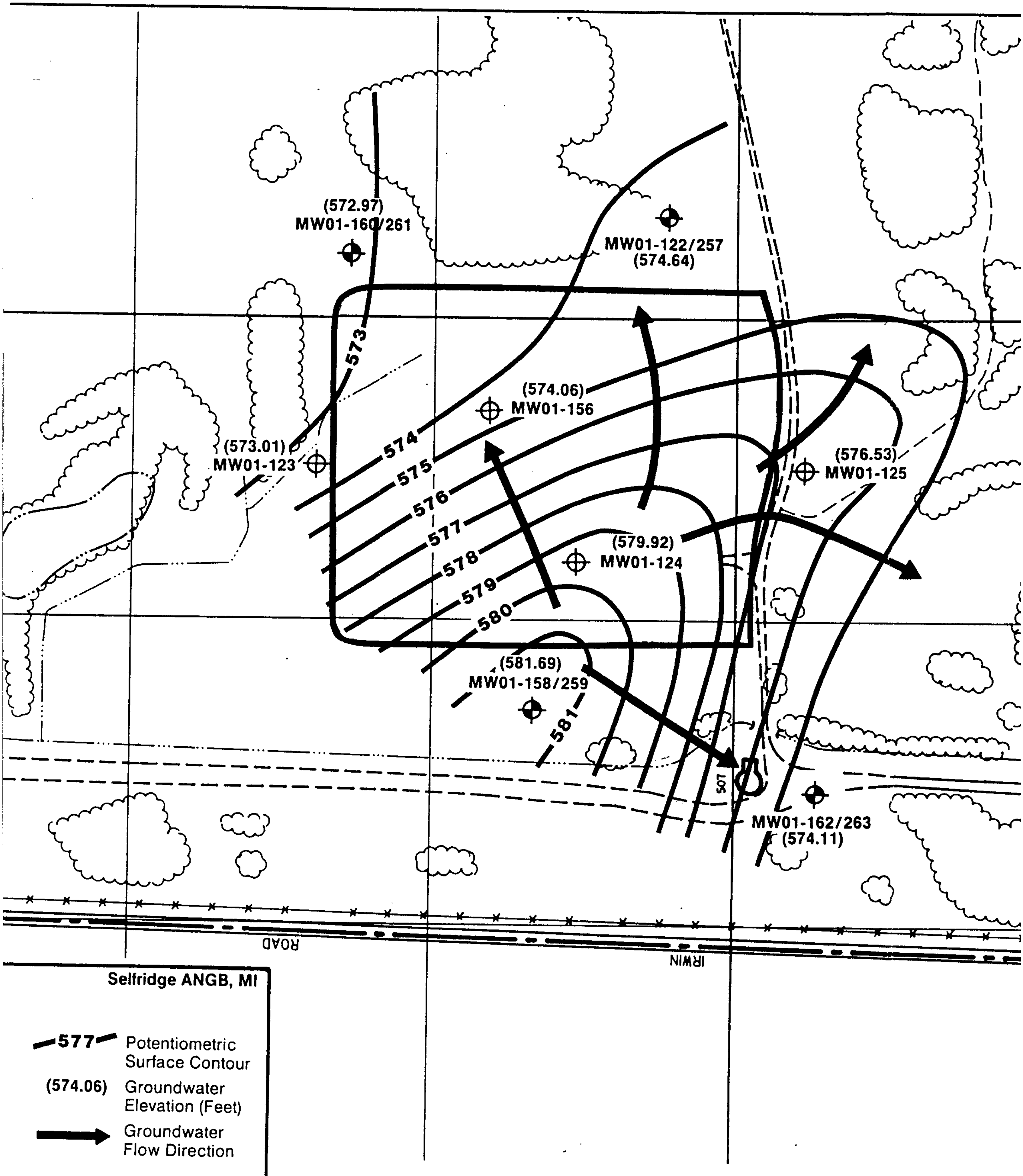

(572.97)
MW01-160/261
MW01-122/257
(574.64)
573
574
575
576
577
578
579
580
581
(574.06)
MW01-156
(573.01)
MW01-123
(576.53)
MW01-125
(579.92)
MW01-124
(581.69)
MW01-158/259
507
MW01-162/263
(574.11)
ROAD
IRWIN
Selfridge ANGB, MI
577 Potentiometric Surface Contour
(574.06) Groundwater Elevation (Feet)
Groundwater Flow Direction

FIGURE 4-3

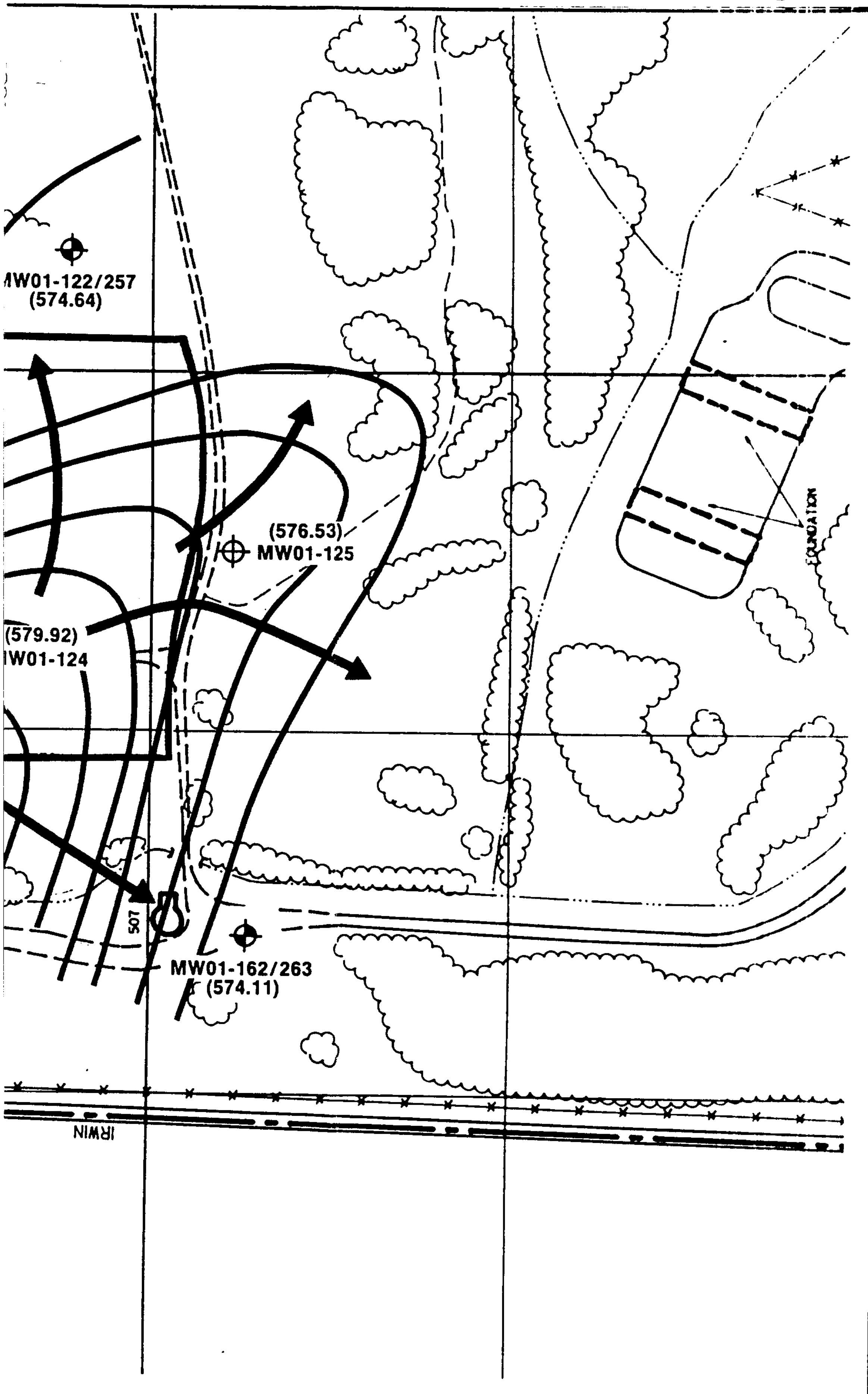
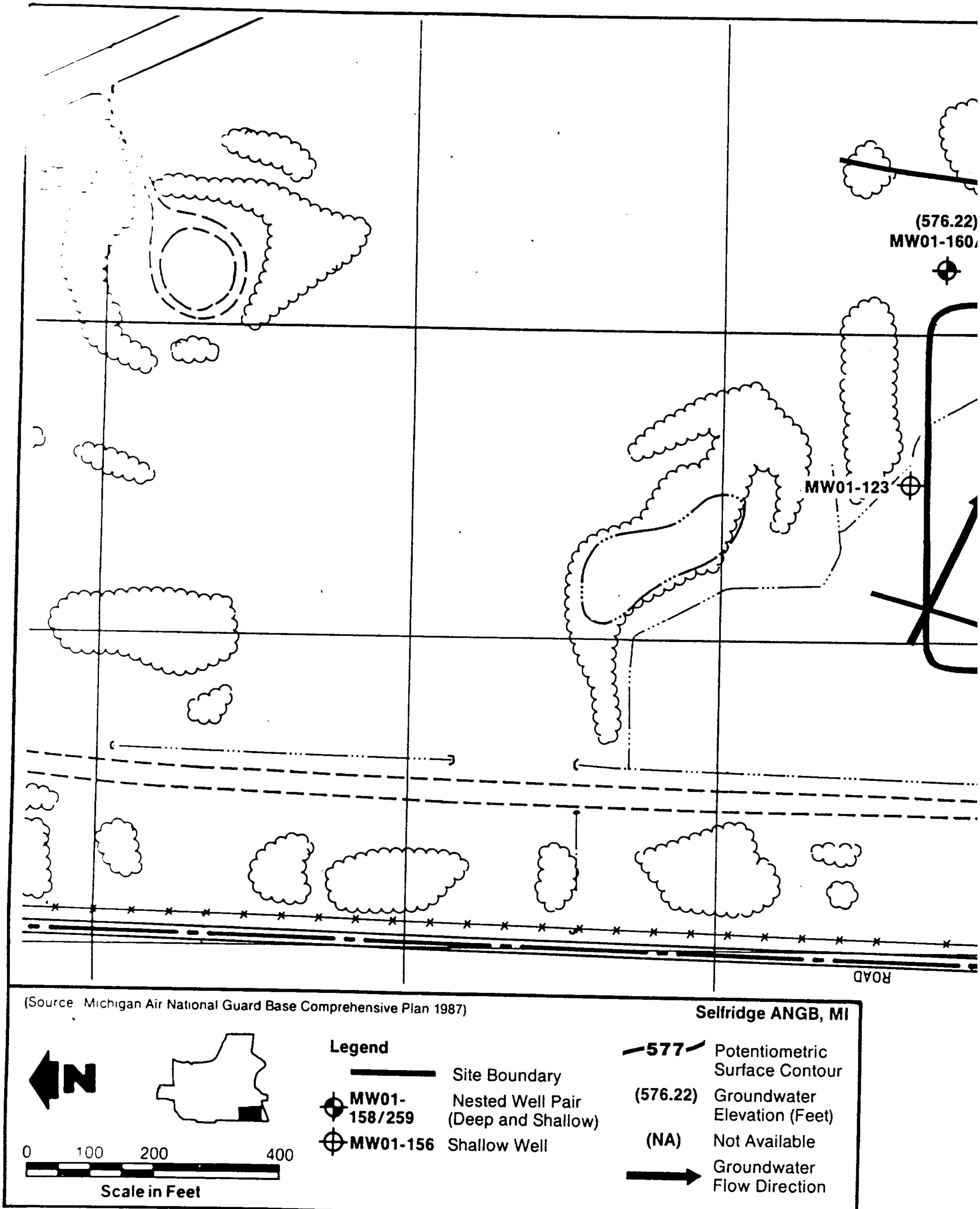
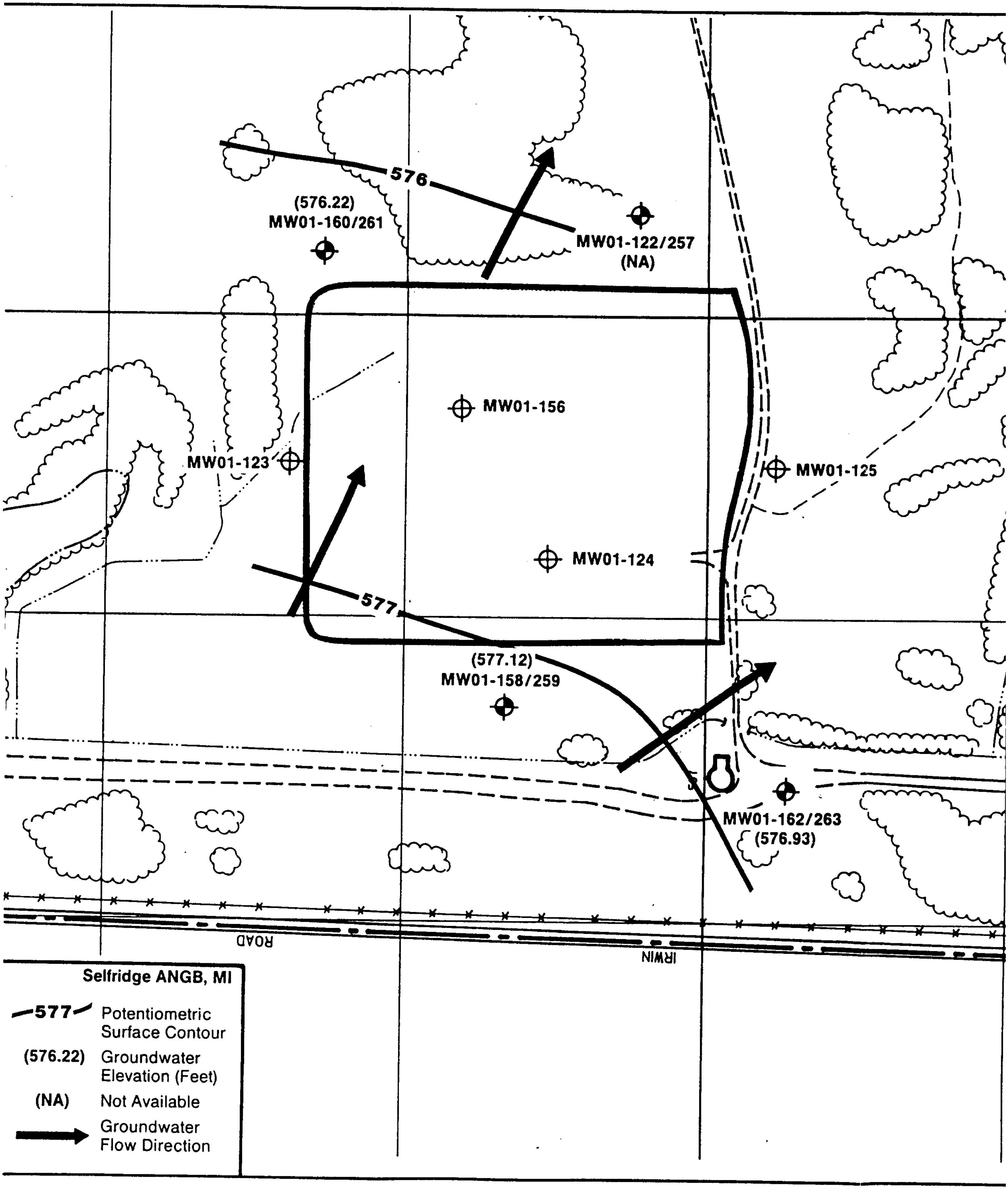


FIGURE 4-30 SWLF POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 1 AUGUST 1988


(576.22)
MW01-160/
MW01-123
ROAD
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0
100
200
400
Scale in Feet
Legend
Site Boundary
MW01-158/259
Nested Well Pair (Deep and Shallow)
MW01-156
Shallow Well
577
Potentiometric Surface Contour
(576.22)
Groundwater Elevation (Feet)
(NA)
Not Available
Groundwater Flow Direction



576
(576.22)
MW01-160/261
MW01-122/257
(NA)
MW01-156
MW01-123
MW01-125
MW01-124
577
(577.12)
MW01-158/259
MW01-162/263
(576.93)
ROAD
IRWIN
Selfridge ANGB, MI
577 Potentiometric Surface Contour
(576.22) Groundwater Elevation (Feet)
(NA) Not Available
Groundwater Flow Direction

FIGURE 4-31

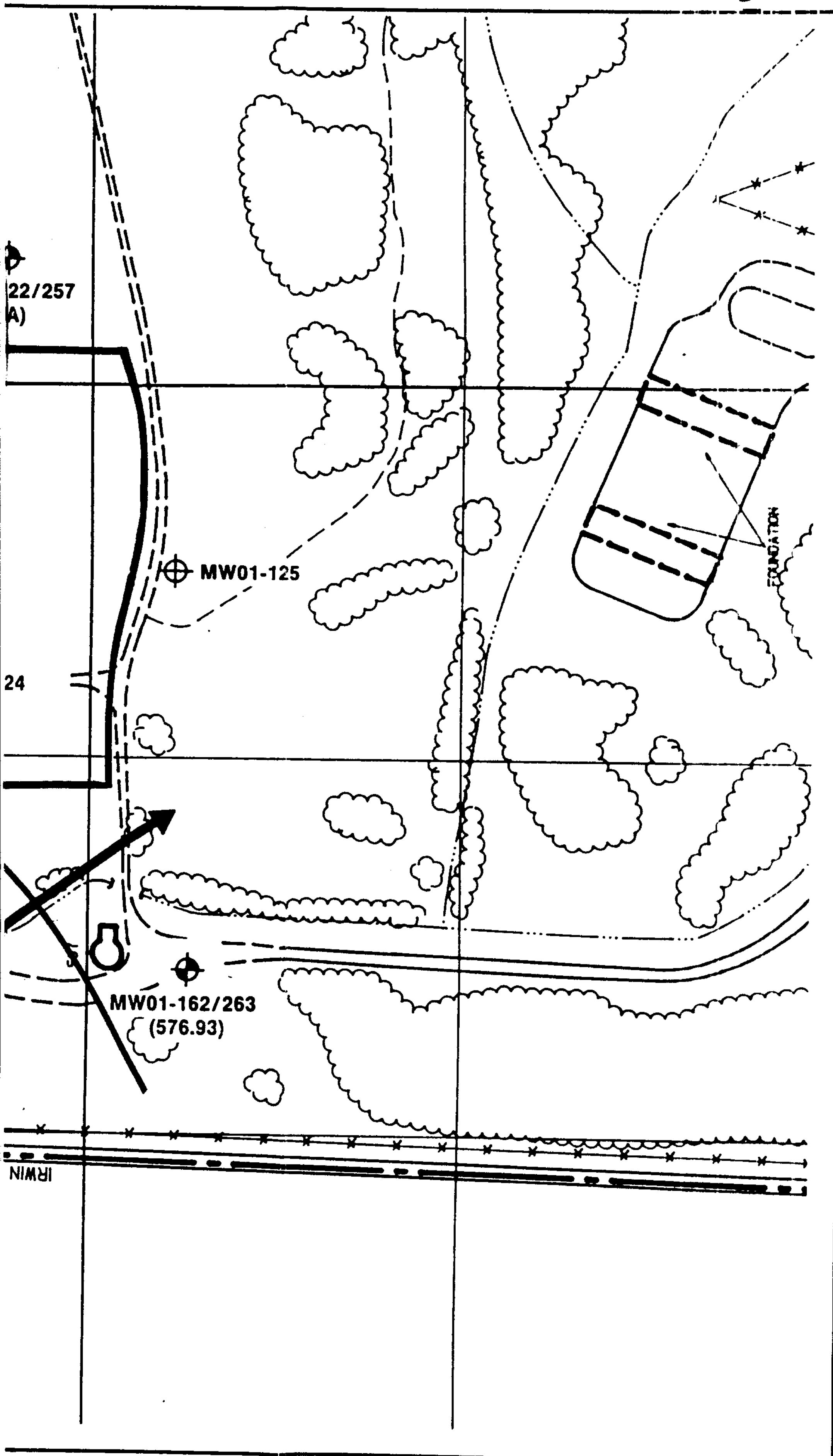
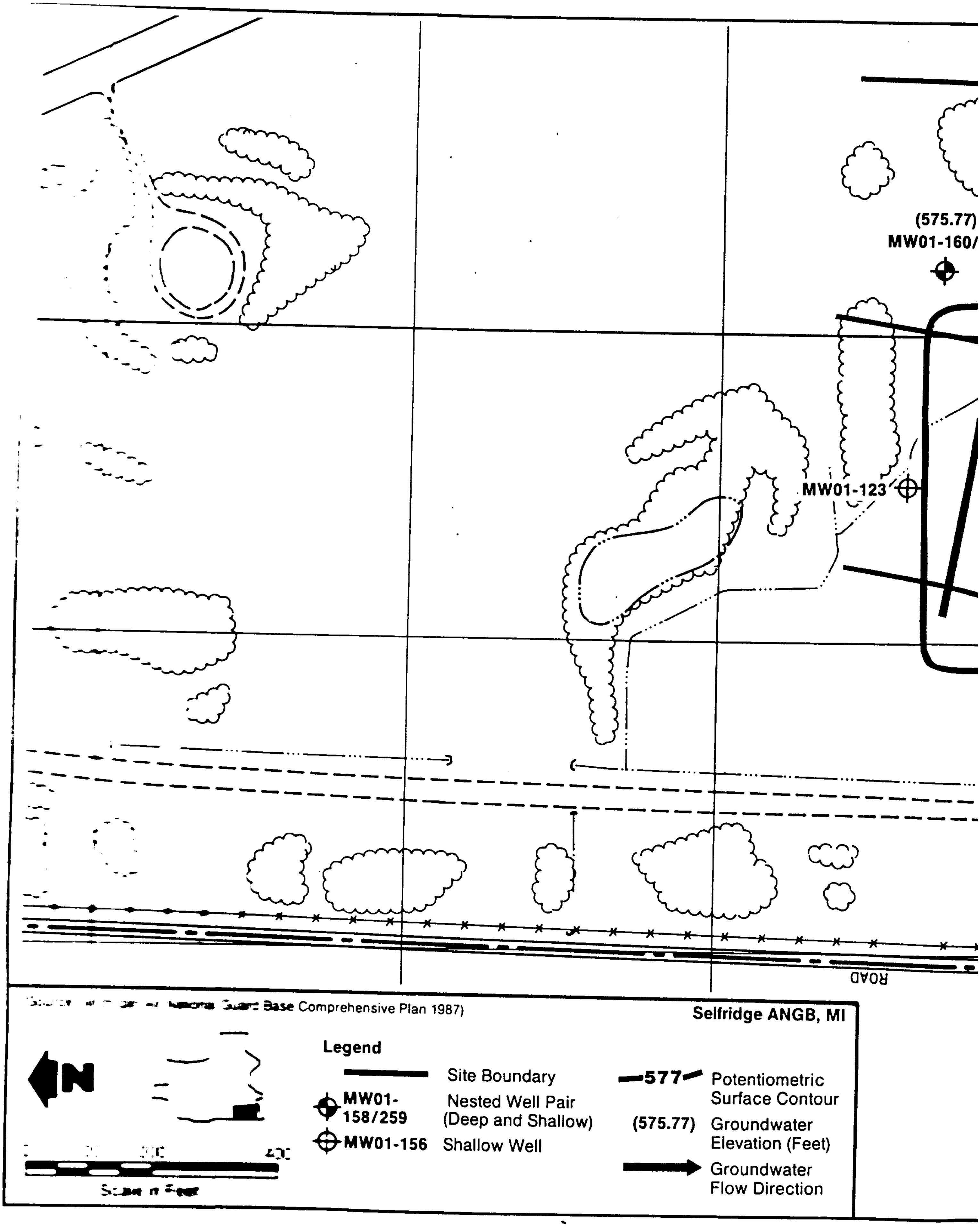


FIGURE 4-31 SWLF POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 21 MARCH 1988



(575.77)
MW01-160/
MW01-123
ROAD
Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW01-158/259
Nested Well Pair (Deep and Shallow)
MW01-156
Shallow Well
577
Potentiometric Surface Contour
(575.77)
Groundwater Elevation (Feet)
Groundwater Flow Direction
N

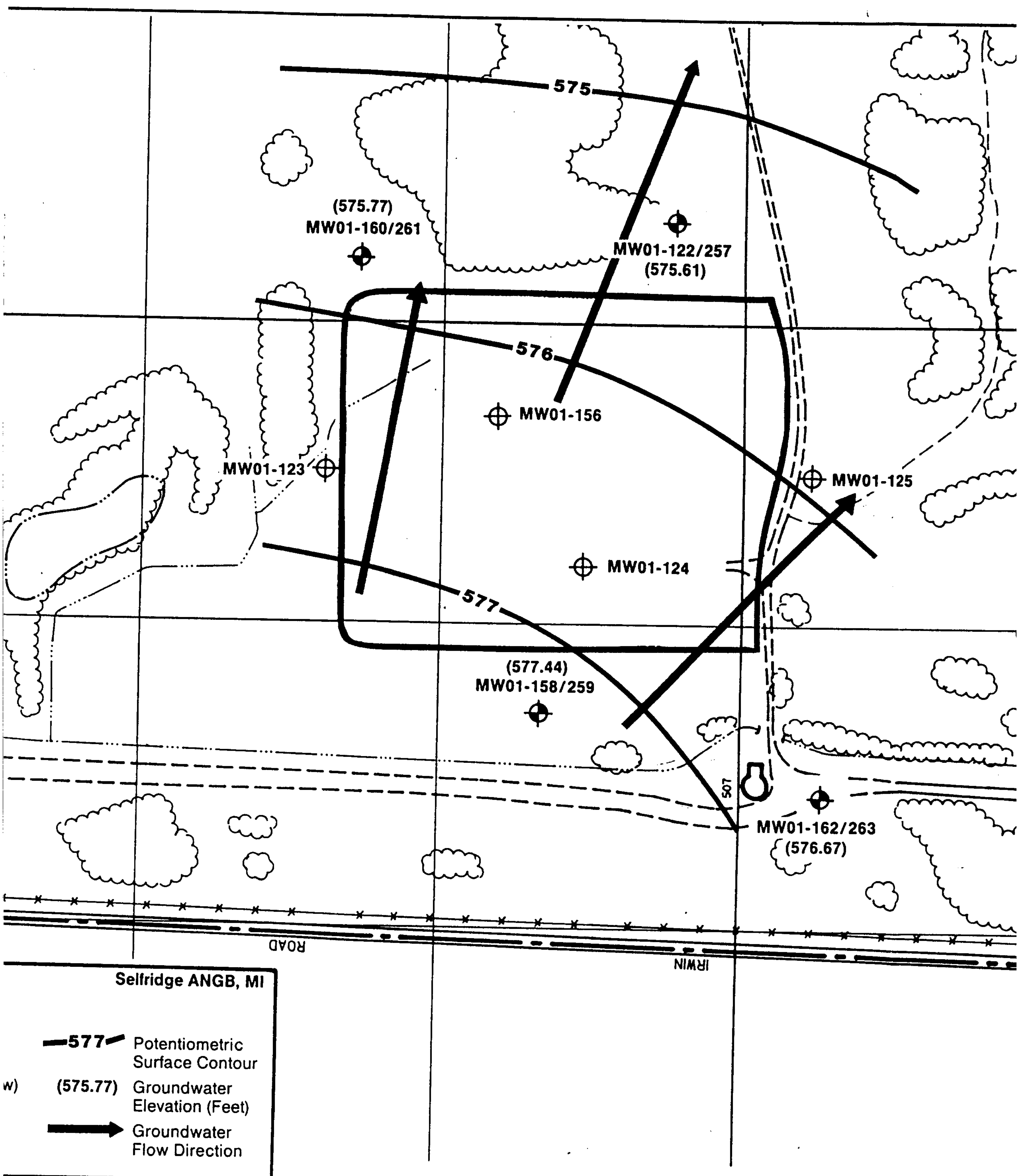

575
576
577
(575.77)
MW01-160/261
MW01-122/257
(575.61)
MW01-156
MW01-123
MW01-125
MW01-124
(577.44)
MW01-158/259
507
MW01-162/263
(576.67)
ROAD
IRWIN
Selfridge ANGB, MI
577 Potentiometric Surface Contour
(575.77) Groundwater Elevation (Feet)
Groundwater Flow Direction

FIGURE 4-3

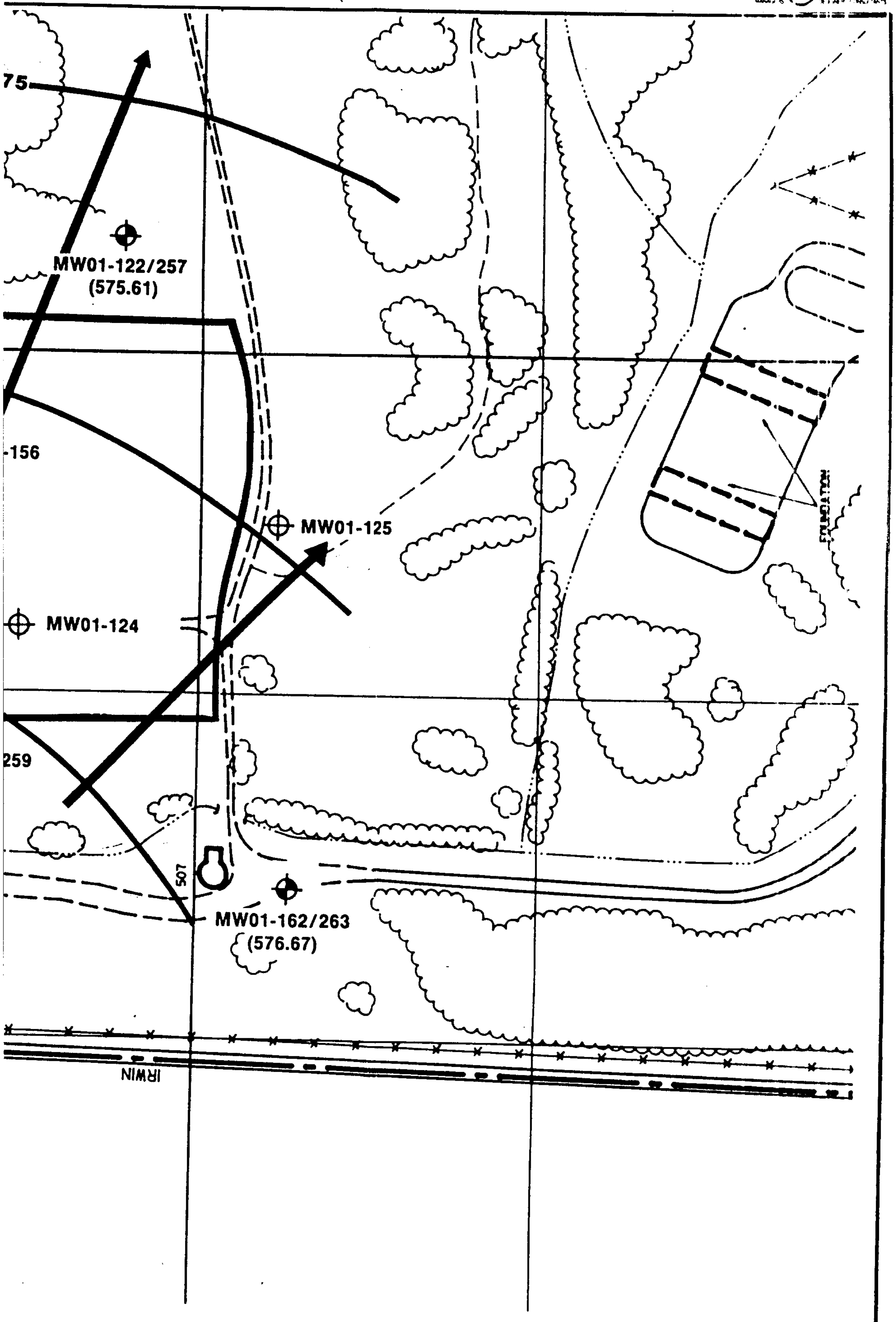


FIGURE 4-32 SWLF POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 1 AUGUST 1988

$\times 10^{-4}$ to 1.72×10^{-6} cm/sec). This range reflects values for both shallow and deep monitor wells. The average K value for all monitor wells is 3.18×10^{-6} ft/sec (9.68×10^{-5} cm/sec). For monitor wells screened mainly in the upper clay (cl) unit the average K value was 1.48×10^{-4} ft/sec (4.51×10^{-3} cm/sec). An average K value of 2.50×10^{-7} ft/sec (7.62×10^{-6} cm/sec) was determined for monitor wells screened in the lower clay (cl) unit.

The groundwater velocity (V) can be calculated for SWLF based upon the K values, the gradient (i), and the effective porosity (n) of the upper and lower clay units using the equation $V = Ki/n$. An effective porosity of 15 percent was used for the clays for the calculation. Groundwater gradients were determined from potentiometric surface maps for both shallow and deep monitor wells on 21 March and 1 August 1988. On 21 March 1988 groundwater velocity for the shallow wells was 7.73×10^{-6} ft/sec (244 ft/ year). Deep monitor wells for this same period show a groundwater velocity of 9.97×10^{-8} ft/sec (3.15 ft/year). Groundwater velocities on 1 August 1988 were 1.93×10^{-5} ft/sec (609 ft/year) and 1.99×10^{-7} ft/sec (6.28 ft/year) for the shallow and deep monitor wells, respectively.

Comparison of the water levels in SWLF shallow monitor wells to the surface elevation of Lake St. Clair for 1 August 1988 indicates that elevations were approximately equal. For this same date the water level elevations in the deep monitor wells range from 1.27 to 3.10 feet higher than the surface of Lake St. Clair. This general trend of higher levels in the monitor wells than the surface of Lake St. Clair was also observed for the other dates when water level measurements were taken.

Vertical gradients were determined for monitor well nests on 1 August 1988. Upward vertical gradients were found at monitor well nests 01-122/257 (0.05 ft/ft), 01-160/261 (0.18 ft/ft), and 01-162/263 (0.17 ft/ft). Monitor well nest 01-158/259 had a downward vertical gradient of 0.21 ft/ft. The downward vertical gradient at this location may be explained by the infiltration of groundwater into the stormwater drainage pipe beneath this location.

4.4.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- SWLF

Two intermittent drainage ditches convey surface water runoff from the area around SWLF (see Figure 4-28). One of the ditches originates from the northeastern corner of the site and flows to the northwest. At the northwestern corner of the site this drainage ditch converges with the other drainage ditch along the perimeter road. The combined drainage ditch appears to flow south, passing by well nests 01-158/259 and 01-162/263. Based upon the elevational difference between ground surface at Pump House 507 and the ditch bottom, the ditch has a depth of approximately 6.5 feet.

Drainage of surface water directly off the SWLF is not controlled by engineered features. This excess water may flow into either of the two drainage ditches or collect in the remnant of the borrow pit to the north of the active landfill. Frequently, following a period of precipitation, stormwater collects in shallow surface depressions located over much of the site and in the low-lying areas around the perimeter of SWLF. Surface water originating from the site may affect the quality of surface water around the site and in the Clinton River.

A stormwater drainage pipe passes underneath the western side of SWLF near the location of well nest 01-158/259. This pipe carries stormwater collected in the southwestern part of the base. This pipe is buried approximately 20 feet BLS, within the saturated zone. The amount of groundwater infiltration to this pipe is unknown. Any groundwater collected by this pipe would be discharged into the Clinton River by the pump station located in Building 507.

Percolation of surface water into SWLF occurs due to the lack of surface grading and the poor integrity or absence of the landfill cap material. Trees and vegetation are allowed to grow on the surface of the landfill, potentially disturbing the integrity of the cap.

4.4.1.5 Direct Contact with Contaminated Media -- SWLF

SWLF is currently an active site for the disposal of demolition debris, miscellaneous equipment, and appliances. The majority of individuals present at the site are base personnel and ground maintenance workers disposing of debris. Base personnel en route to the Ordnance Disposal Area must also pass through the SWLF site. These personnel have the greatest potential to come in direct contact with contaminants at the site. Due to the lack of physical access restrictions at the site, the possibility exists that visitors to the base could enter the SWLF and come in direct contact with contaminants.

Future use of the alluvial sand as a source of fill material could result in workers coming in contact with contaminants and in spreading contaminants to other areas of the base. The sand may serve as a pathway for contaminant exposure.

Landfill gas was observed bubbling through water ponded on the surface of the landfill. This gas may serve as a pathway for contaminant exposure via air.

4.4.1.6 Summary of Migration Pathways -- SWLF

Precipitation falling on SWLF comes in direct contact with the landfill material protruding through the surface or covered by a thin layer of cap material. Excess surface water ponding on the landfill may percolate into the landfill and alluvial material found at SWLF.

Landfill waste buried in the vicinity of monitor well nest 01-158/259 along the perimeter road next to the drainage ditch may contribute leachate to the surface water. Groundwater moving through this area may also be discharged into the drainage ditch. The west-facing slopes of these trenches serve as the eastern bank of this drainage ditch. The possible occurrence of bank storage of water during runoff events allows for the opportunity for water to percolate into the landfill debris. Following a storm event, the water can either be released from storage to the ditch or contribute to the groundwater system. Base personnel working in the SWLF area may come in contact with contaminated water. In addition, runoff of stormwater across the landfill is uncontrolled and untreated. This water may pick up contaminants from the surface and transport them to other areas of the base.

Groundwater may infiltrate into the stormwater drainage pipe beneath the western side of the site. The water would then be discharged by the pump station into the Clinton River.

Wildlife, such as ducks and deer, observed living in the area immediately in and around SWLF can potentially come in contact with contaminants. Ponded areas of water on the SWLF site or in the drainage ditches flowing by the site serve as drinking water sources and aquatic habitat.

4.4.2 Contamination Profile -- SWLF

4.4.2.1 Chemical Results for Soil -- SWLF

Four investigative soil samples retained from the SWLF were analyzed for chemical contaminants during this investigation. The four samples were taken from borings at monitor wells 01-257, 01-259, 01-261, and 01-263. The soil sampling depths in these borings were from 4 to 8 feet, 10 to 15 feet, 15 to 20 feet, and 15 to 20 feet BLS, respectively. The soil sampling locations were chosen because the borings for monitor wells 01-259 and 01-263 were believed to upgradient of the landfill, and the borings for monitor wells 01-257 and 01-261 were believed to be downgradient. During drilling monitor well 01-259 was discovered to be within the landfill. The soil sample in this boring was taken from the clay soil directly under the fill.

Borings were drilled and soil samples retained on 24 January 1988 for sample 01-363-B001 (monitor well location 01-263), on 2 February 1988 for sample 01-359-B001 (monitor well location 01-259), on 3 February 1988 for sample 01-361-B001 (monitor well location 01-261), and on 22 March 1988 for sample 01-357-B001 (monitor well location 01-261). The soils were sent to WESTON/Gulf Coast Laboratories and were analyzed for petroleum hydrocarbons; volatile organics; semivolatile organics; soil moisture content; and metals screen, including arsenic, mercury, and selenium. No holding times were exceeded for these

samples. For the volatile organic analyses surrogate recoveries ranged from 88 to 110 percent and matrix spike recoveries from 91 to 125 percent. For the semivolatile organic analyses surrogate recoveries ranged from 24 to 126 percent and matrix spike recoveries from 79 to 112 percent. Although the surrogate recoveries were low for sample 01-361-B001 (24 to 67 percent), the detection limits (0.51 to 2.3 mg/kg) were within acceptable limits.

The volatile organic analyses detected a number of common laboratory and method contaminants in the four investigative soil samples. These included acetone (0.073 to 0.44 mg/kg), 2-butanone (0.34 mg/kg), and 4-methyl-2-pentanone (0.66 mg/kg). Methylene chloride, acetone, toluene, and 2-butanone were detected in associated quality control blanks, invalidating detections of 2-butanone and methylene chloride in 01-361-B001, acetone in 01-357-B001, and toluene in 01-359-B001.

Table 4-29 lists the valid analytes and concentrations detected in soil samples collected at SWLF. Soil sample 01-359-B001, which is from clay soils below the waste at location 01-158/259, contained acetone (0.44 mg/kg), 2-butanone (0.34 mg/kg), 4-methyl-2-pentanone (0.66 mg/kg), diethyl ether (0.15 mg/kg), and 1,2-dichloroethene (0.1 mg/kg). Other organic contaminants detected in this soil sample included petroleum hydrocarbons (180 mg/kg) and phenol (<0.45 mg/kg).

Soil sample 01-361-B001, which is from location 01-261 at the northeastern corner of the defined extent of the landfill, contained only acetone (0.046 mg/kg). Soil sample 01-363-B001, which is from location 01-263 southwest of the site and west of Perimeter Road, contained concentrations of petroleum hydrocarbons at 77 mg/kg and acetone at 0.073 mg/kg. Soil sample 01-357-B001, which is from location 01-257 at the southeastern corner of the defined extent of the landfill, contained a suite of 13 semivolatile organic constituents in low concentrations (<0.03 to <0.20 mg/kg). These semivolatile organics, typical of coal tar or wood preservatives often used on railroad ties, included fluoranthene, pyrene, chrysene, and benzo(g,h,i)perylene. Di-n-butyl phthalate, which is a common plasticizer, was also detected.

All metals screen concentrations were within the naturally occurring observed ranges for the eastern conterminous United States (USGS Professional Paper 1270, 1984). A few metals were above background levels for Selfridge ANGB as determined by statistical analysis (see Table 4-20). Soil sample 01-357-B001 (lab dup) contained an above-background concentration of lead (22.9 mg/kg). The lead concentration for that sample is close to that sample's detection limit of 19.8 mg/kg; primary sample 01-357-B001 did not contain lead above its detection limit of 19.9 mg/kg. Only one other soil sample at the base (05-403-B001) contained lead in detectable concentrations. Soil sample

TABLE 4-29

VALID ANALYTES DETECTED IN SOIL AT SWLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE / DEPTH / % MOISTURE	01-357-B001 / 126649 / 22-MAR-88 / 4-8 FEET / 15.7			01-357-B001 / 126649 LAB DUP / 22-MAR-88 / 4-8 FEET / 15.7			01-259-B001* / 123088 / 02-FEB-88 / 10-15 FEET / 31.0			01-261-B001* / 123369 / 03-FEB-88 / 15-20 FEET / 35.0			01-363-B001 / 122410 / 24-JAN-88 / 15-20 FEET / 32.8		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ACETONE	SW5030/SW8240	0.012		NV	0.012		NV	0.014	0.44	=	0.015	0.046	=	0.015	0.073	=
1,2-DICHLOROETHENE (TOTAL)	SW5030/SW8240	0.006		ND	0.006		ND	0.007	0.1	=	0.008		ND	0.007		ND
2-BUTANONE	SW5030/SW8240	0.012		ND	0.012		ND	0.014	0.34	=	0.015		NV	0.015		ND
4-METHYL-2-PENTANONE	SW5030/SW8240	0.012		ND	0.012		ND	0.014	0.66	=	0.015		ND	0.015		ND
DIETHYL ETHER	SW5030/SW8240	0.12		ND	0.12		ND	0.14	0.15	=	0.15		ND	0.15		ND
PHENOL	SW3550/SW8270	0.39		ND				0.47	0.45	<	0.51		ND	0.51		ND
PHENANTHRENE	SW3550/SW8270	0.39	0.18	<				0.47		ND	0.51		ND	0.51		ND
ANTHRACENE	SW3550/SW8270	0.39	0.05	<				0.47		ND	0.51		ND	0.51		ND
DI-N-BUTYL PHTHALATE	SW3550/SW8270	0.39	0.03	<				0.47		ND	0.51		ND	0.51		ND
FLUORANTHENE	SW3550/SW8270	0.39	0.20	<				0.47		ND	0.51		ND	0.51		ND
PYRENE	SW3550/SW8270	0.39	0.15	<				0.47		ND	0.51		ND	0.51		ND
BENZO(A)ANTHRACENE	SW3550/SW8270	0.39	0.11	<				0.47		ND	0.51		ND	0.51		ND
CHRYSENE	SW3550/SW8270	0.39	0.11	<				0.47		ND	0.51		ND	0.51		ND
BIS(2-ETHYLHEXYL) PHTHALATE	SW3550/SW8270	0.39	0.12	<				0.47		ND	0.51		ND	0.51		ND
BENZO(B)FLUORANTHENE	SW3550/SW8270	0.39	0.15	<				0.47		ND	0.51		ND	0.51		ND
BENZO(K)FLUORANTHENE	SW3550/SW8270	0.39	0.08	<				0.47		ND	0.51		ND	0.51		ND
BENZO(A)PYRENE	SW3550/SW8270	0.39	0.12	<				0.47		ND	0.51		ND	0.51		ND
INDENO(1,2,3-C,D)PYRENE	SW3550/SW8270	0.39	0.12	<				0.47		ND	0.51		ND	0.51		ND
BENZO(G,H,I)PERYLENE	SW3550/SW8270	0.39	0.11	<				0.47		ND	0.51		ND	0.51		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	125		ND	125		ND	71.4	180	=	76.9		ND	73.3	77	=
ALUMINUM, TOTAL	SW3050/SW6010	.20	2690	=	19.8	3130	=	19.6	17000	=	19.9	14300	=	19.5	16400	=
ARSENIC, TOTAL	SW3050/SW7060	.91	4.65	=				4.8		ND	10		ND	9.8	17.1	=
BORON, TOTAL	SW3050/SW6010	19.9		ND	19.8		ND	19.6	33.3	=	19.9	25.4	=	19.5	29.3	=
BARIUM, TOTAL	SW3050/SW6010	2.5	23.9	=	2.5	25.7	=	2.4	98.8	=	2.5	104	=	2.4	122	=
BERYLLIUM, TOTAL	SW3050/SW6010	.20		ND	.20		ND	0.19	0.66	=	0.2	0.79	=	0.2	1	=
CALCIUM, TOTAL	SW3050/SW6010	10.0	21600	=	9.9	24613	=	9.8	32900	=	10	35400	=	9.8	55900	=
CADMIUM, TOTAL	SW3050/SW6010	1.0		ND	.99		ND	0.98	1.8	=	1	1.6	=	0.98	1.1	=
COBALT, TOTAL	SW3050/SW6010	4.0		ND	4.0		ND	3.9		NV	4	12.8	=	3.9	13.6	=
CHROMIUM, TOTAL	SW3050/SW6010	2.0	6.06	=	2.0	6.35	=	2	26.3	=	2	23.9	=	2	25.4	=
COPPER, TOTAL	SW3050/SW6010	3.0	10.7	=	3.0	12.1	=	2.9	23.1	=	3	17.6	=	2.9	20.1	=
IRON, TOTAL	SW3050/SW6010	4.0	5350	=	4.0	6390	=	3.9	25500	=	4	24200	=	3.9	26500	=
MERCURY, TOTAL	SW7471	.040		ND				0.038	0.959	=	0.034		ND	0.039		ND
POTASSIUM, TOTAL	SW3050/SW6010	996		ND	992		ND	982	3740	=	996	3240	=	977	3600	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.9	5230	=	19.8	5820	=	19.6	16900	=	19.9	12900	=	19.5	14000	=
MANGANESE, TOTAL	SW3050/SW6010	1.0	92.2	=	.99	99.9	=	0.98	349	=	1	402	=	0.98	501	=
SODIUM, TOTAL	SW3050/SW6010	89.6		ND	89.3	93.3	=	88.4	465	=	89.6	471	=	87.9	457	=
NICKEL, TOTAL	SW3050/SW6010	5.0	6.45	=	5.0	6.71	=	4.9	30.8	=	5	37.1	=	4.9	382	=
LEAD, TOTAL	SW3050/SW6010	19.9		ND	19.8	22.9	=	19.6		ND	19.9		ND	19.5		ND
SILICON, TOTAL	SW3050/SW6010	29.9	86.6	=	29.8	132	=	19.6	64.6	=	19.9	477	=	19.5	134	=
VANADIUM, TOTAL	SW3050/SW6010	4.0	7.35	=	4.0	8.19	=	4	31.9	=	4	29.3	=	3.9	33.6	=
ZINC, TOTAL	SW3050/SW6010	1.0	52.9	=	.99	61.6	=	0.98	78.3	=	1	59.5	=	0.98	64.7	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

*SAMPLES 01-259 AND 01-261 WERE INCORRECTLY LABELED AND ENTERED ON THE CHAIN-OF-CUSTODY FORMS. THE CORRECT NUMBERS, 01-359 AND 01-361, ARE USED IN THE TEXT.

01-359-B001 contained mercury (0.959 mg/kg). It was the only soil sample tested at Selfridge ANGB to contain detectable concentrations of mercury. Chromium (26.3 mg/kg) and zinc (78.3 mg/kg) were also detected in concentrations above statistically determined background levels in soil sample 01-359-B001. Soil sample 01-363-B001 contained the largest concentration of nickel (382 mg/kg) detected on base, well above the statistically determined maximum background value (41.8 mg/kg).

The inorganic constituents in soil sample 01-235 are significantly lower in concentration than in the other soil samples collected at SWLF, reflecting the mineralogy for the type of soil being analyzed. Soil sample 01-257 is a sand, while the other three soil samples are clays.

4.4.2.2 Chemical Results for Groundwater -- SWLF

One duplicate and 12 investigative groundwater samples were collected for analyses of chemical contaminants during this investigation. They were collected from wells placed around and within the perimeter of SWLF with the intent of detecting groundwater contamination from landfilling practices. The groundwater samples were collected from 6 April to 12 April 1988.

All groundwater samples from all sites were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, chemical oxygen demand (COD), total organic carbon (TOC), alkalinity, and total dissolved solids (TDS). Holding times were exceeded for ammonia in all groundwater samples collected from monitor wells at SWLF and for COD for every groundwater sample except 01-259-M001, 01-261-M001, 01-263-M001, and 01-257-M001. These wells were resampled on 7 August 1988. No holding times were exceeded for the resampled groundwater.

Surrogate recoveries for purgeable halocarbons analyses ranged from 18 to 132 percent. Surrogate recoveries for purgeable aromatics ranged from 107 to 152 percent. Semivolatile surrogate recoveries ranged from 23 to 170 percent, except for sample 01-122-M101, which was re-extracted. However, surrogate recoveries remained out of QC limits (0 to 143 percent), indicating a matrix effect. The matrix spike recoveries for semivolatiles ranged from 49 to 111 percent.

A complete list of valid analytes and concentrations detected in groundwater samples collected at SWLF is presented in Table 4-30. Two groundwater samples (01-124-M001 and 01-158-M001) contain significant amounts of several organic contaminants. Both samples are from shallow wells from the western side of the

TABLE 4-30

VALID ANALYTES DETECTED IN GROUNDWATER AT SWLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE		01-122-M001 / 127645 / 06-APR-88			01-122-M101 / 127651 / 06-APR-88			01-123-M001 / 127646 / 06-APR-88			01-124-M001 / 127647 / 06-APR-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
1,1-DICHLOROETHANE	E601	ug/L	0.4		ND	0.4		ND	0.4		ND	0.4		ND
1,2-DICHLOROETHANE	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2	3.1 (5.1)	=
TRANS-1,2-DICHLOROETHENE	E601	ug/L	0.5		ND	0.5		ND	0.5		ND	0.5	29 (ND)	=
DICHLORODIFLUOROMETHANE	E601	ug/L	9		ND	9		ND	9		ND	9	ND (15)	=
METHYLENE CHLORIDE	E601	ug/L	2		ND	2		ND	2		ND	2		NV
VINYL CHLORIDE	E601	ug/L	0.3		ND	0.3		ND	0.3		ND	0.3	2.3 (1.7)	=
TETRACHLOROETHENE	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
1,1,2,2-TETRACHLOROETHANE	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
TRICHLOROETHENE	E601	ug/L	0.6		ND	0.6		ND	0.6		ND	0.6	6.7 (6.2)	=
CHLOROFORM	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
BENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2	29 (50)	=
TOLUENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2	240 (180)	=
1,3-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND
1,4-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND
ETHYLBENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2	5 (11)	=
XYLENES	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	9		ND	10		ND	10		ND
DIETHYL PHTHALATE	E625	ug/L	10		ND	9		ND	10		ND	10		ND
DI-N-BUTYL PHTHALATE	E625	ug/L	10	2	<	9		ND	10		ND	10	2	<
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10		NV	9		ND	10		ND	10		NV
2,4-DIMETHYLPHENOL	E625	ug/L	10		ND	9		ND	10		ND	10	15	=
PHENOL	E625	ug/L	10		ND	9		ND	10		ND	10	210	=
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00		ND	1.00		ND	1.00		ND	1.02		ND
SILVER, TOTAL	E200.7	mg/L	.0100		ND	.0100		ND	.0100		ND	.0100	0.014	=
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050	0.01	=
BORON, TOTAL	E200.7	mg/L	.100	0.777	=	.100	0.731	=	.100	0.196	=	.100	0.411	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.111	=	.0500	0.058	=	.0500	0.139	=	.0500	0.765	=
CALCIUM, TOTAL	E200.7	mg/L	.200	192	=	.200	185	=	.200	132	=	.200	800	=
CADMIUM, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050	0.022	=
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND	.0100		ND	.0100		ND	.0100		ND
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND	.0250		ND	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400	1.02	=	.0400	0.688	=	.0400		NV	.0400	81.6	=
POTASSIUM, TOTAL	E200.7	mg/L	5.00	14.8	ND	5.00	13.6	ND	5.00		ND	5.00		ND
MAGNESIUM, TOTAL	E200.7	mg/L	.200	114	=	.200	112	=	.200	51.5	=	.200	321	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	1.41	=	.0100	1.44	=	.0100	0.412	=	.0100	0.915	=
SODIUM, TOTAL	E200.7	mg/L	.900	68.1	=	.900	67.1	=	.900	89.4	=	.900	203	=
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150		ND	.0150	0.016	=	.0150	0.057	=
SILICON, TOTAL	E200.7	mg/L	.300	4.61	=	.300	4.55	=	.300	5.61	=	.300	8.44	=
ZINC, TOTAL	E200.7	mg/L	.0100		NV	.0100		NV	.0100		NV	.0100	0.105	=
ALKALINITY	A403	mg/L	10	900	=	10	670	=	10	470	=	10	1300	=
COD	A508A	mg/L	5		HT	5		HT	5		HT	5		HT
FLUORIDE	E340.2	mg/L	0.1	0.3	=	0.1	0.2	=	0.1	0.4	=	0.1	0.3	=
NITRATE/NITRITE	E353.1	mg/L	0.1	ND	ND	0.1		ND	0.2		ND	0.4		ND
AMMONIA	E350.3	mg/L	0.1		HT	0.1		HT	0.1		HT	0.1		HT
TOC	E415.1	mg/L	1	9.4	=	1.0	8.8	=	1.0	4.9	=	100	1100	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	1800	=	10	1800	=	10	990	=	10	5900	=
	SAMPLE # / RFW # / SAMPLE DATE		01-122-M001 / 8804-009-001 / 06-APR-88			01-122-M101 / 8804-009-007 / 06-APR-88			01-123-M001 / 8804-009-002 / 06-APR-88			01-124-M001 / 8804-009-003 / 06-APR-88		
CHLORIDE	A429	mg/L	25	87	=	25	44	=	25	297	=	250	1810	=
SULFATE	A429	mg/L	62.5	475	=	25	233	=	25	62	=	2.5		ND
	SAMPLE # / RFW # / SAMPLE DATE		01-122-M021 / 137187 / 07-AUG-88			01-125-M121 / 137183 / 07-AUG-88			01-123-M021 / 137191 / 07-AUG-88			01-124-M021 / 137194 / 07-AUG-88		
COD	A508A	mg/L	5	31	=	5	30	=	5	480	=	5	1800	
AMMONIA	E350.3	mg/L	0.1	0.8	=	0.1	0.7	=	0.1	1	=	0.1	0.4	

DL - SAMPLE DETECTION LIMIT
R - RESULTS
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-30

(CONTINUED)

ANALYTE	SAMPLE # / RFW # / SAMPLE DATE		01-125-M001 / 127648 / 06-APR-88			01-156-M001 / 127649 / 06-APR-88			01-158-M001 / 127691 / 06-APR-88			01-160-M001 / 127692 / 06-APR-88		
	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
1,1-DICHLOROETHANE	E601	ug/L	0.4		ND	0.4		ND	0.4	7.9 (12)	=	0.4		ND
1,2-DICHLOROETHANE	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
TRANS-1,2-DICHLOROETHENE	E601	ug/L	0.5		ND	0.5		ND	0.5	650 (ND)	=	0.5		ND
DICHLORODIFLUOROMETHANE	E601	ug/L	9		ND	9		ND	9	450 (109)	=	9		ND
METHYLENE CHLORIDE	E601	ug/L	2		ND	2		ND	2	310 (ND)	=	2		ND
VINYL CHLORIDE	E601	ug/L	0.3		ND	0.3		ND	0.3	68 (21)	=	0.3		ND
TETRACHLOROETHENE	E601	ug/L	0.2		ND	0.2		ND	0.2	3.9 (ND)	=	0.2		ND
1,1,2,2-TETRACHLOROETHANE	E601	ug/L	0.2		ND	0.2		ND	0.2	7.3 (ND)	=	0.2		ND
TRICHLOROETHENE	E601	ug/L	0.6		ND	0.6		ND	0.6	170 (ND)	=	0.6		ND
CHLOROFORM	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
BENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2	60 (20)	=	2		ND
TOLUENE	SW5030/SW8020	ug/L	2		ND	2		ND	2	650 (370)	=	2		ND
1,3-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5	93 (ND)	=	5		ND
1,4-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5	9 (18)	=	5		ND
ETHYLBENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2	92 (56)	=	2		ND
XYLENES	SW5030/SW8020	ug/L	5		ND	5		ND	5	210 (99)	=	5		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND
DIETHYL PHTHALATE	E625	ug/L	10		ND	10		ND	10	160	=	10		NV
DI-N-BUTYL PHTHALATE	E625	ug/L	10	2	<	10		ND	10	10	=	10		ND
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10	2	<
2,4-DIMETHYLPHENOL	E625	ug/L	10		ND	10		ND	10	80	=	10		ND
PHENOL	E625	ug/L	10		ND	10		ND	10	240	=	10		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00		ND	1.00		ND	1.00	1	=	1.09	5	=
SILVER, TOTAL	E200.7	mg/L	.0100		ND	.0100		ND	.0100		ND	.0100		ND
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050	0.01	=	.0050		ND	.0050		ND
BORON, TOTAL	E200.7	mg/L	.100	0.629	=	.100	1.24	=	.100	1.35	=	.100		ND
BARIUM, TOTAL	E200.7	mg/L	.0500	0.169	=	.0500	0.249	=	.0500	0.716	=	.0500	0.102	=
CALCIUM, TOTAL	E200.7	mg/L	.200	131	=	.200	143	=	.200	436	=	.200	72.5	=
CADMIUM, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050	0.047	=	.0050		ND
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND	.0100		ND	.0100		ND	.0100		ND
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND	.0250		ND	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400		NV	.0400		NV	4	700	=	.0400		NV
POTASSIUM, TOTAL	E200.7	mg/L	5.00	14.1	=	5.00		ND	5.00	30.7	=	5.00		ND
MAGNESIUM, TOTAL	E200.7	mg/L	.200	35.4	=	.200	83.3	=	.200	88	=	.200	25.2	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	2.1	=	.0100	1.07	=	.0100	6.73	=	.0100	0.149	=
SODIUM, TOTAL	E200.7	mg/L	.900	85.8	=	.900	252	=	.900	188	=	.900	43.4	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.018	=	.0150	0.087	=	.0150		ND	.0150		ND
SILICON, TOTAL	E200.7	mg/L	.300	4.97	=	.300	8.81	=	.300	7.63	=	.300	4.62	=
ZINC, TOTAL	E200.7	mg/L	.0100		NV	.0100		NV	.0100	1.74	=	.0100		NV
ALKALINITY	A403	mg/L	10	2500	=	10	190	=	10	1300	=	10	340	=
COD	A508A	mg/L	5		HT	5		HT	5		HT	5		HT
FLUORIDE	E340.2	mg/L	0.1	0.3	=	0.1	0.2	=	0.1		ND	0.1	0.2	=
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.2		ND	2		ND	0.1		ND
AMMONIA	E350.3	mg/L	0.1		HT	0.1		HT	0.1		HT	0.1		HT
TOC	E415.1	mg/L	1.0	13	=	5	52	=	100	2000	=	1.0	2.7	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	880	=	10	1400	=	10	2600	=	10	560	=

	SAMPLE # / RFW # / SAMPLE DATE		01-125-M001 / 8804-009-004 / 06-APR-88			01-156-M001 / 8804-009-004 / 06-APR-88			01-158-M001 / 8804-033-001 / 06-APR-88			01-160-M001 / 8804-033-002 / 06-APR-88		
CHLORIDE	A429	mg/L	25	110	=	62.5	342	=	2.5	1.74	=	25	115	=
SULFATE	A429	mg/L	25	112	=	2.5	14.2	=	2.5	13.1	=	25	36	=

	SAMPLE # / RFW # / SAMPLE DATE		01-125-M021 / 137182 / 07-AUG-88			01-156-M021 / 137195 / 07-AUG-88			01-158-M021 / 137203 / 07-AUG-88			01-160-M021 / 137189 / 07-AUG-88		
COD	A508A	mg/L	5	100	=	5	380	=	5	7000	=	5		ND
AMMONIA	E350.3	mg/L	0.1	0.6	=	0.1	4.6	=	0.1	1.7	=	0.1	12	=

DL - SAMPLE DETECTION LIMIT
R - RESULTS
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-30

(CONTINUED)

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE # RFW # SAMPLE DATE		01-162-M001 127650 06-APR-88			01-257-M001 128048 12-APR-88			01-259-M001 128049 12-APR-88			01-261-M001 128050 12-APR-88		
1,1-DICHLOROETHANE	E601	ug/L	0.4		ND	0.4		ND	0.4		ND	0.4		ND
1,2-DICHLOROETHANE	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
TRANS-1,2-DICHLOROETHENE	E601	ug/L	0.5		ND	0.5		ND	0.5		ND	0.5		ND
DICHLORODIFLUOROMETHANE	E601	ug/L	9		ND	9		ND	9		ND	9		ND
METHYLENE CHLORIDE	E601	ug/L	2		ND	2	6 (ND)	=	2	4 (13)	=	2	5 (ND)	=
VINYL CHLORIDE	E601	ug/L	0.3		ND	0.3		ND	0.3		ND	0.3		ND
TETRACHLOROETHENE	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
1,1,2,2-TETRACHLOROETHANE	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
TRICHLOROETHENE	E601	ug/L	0.6		ND	0.6		ND	0.6		ND	0.6		ND
CHLOROFORM	E601	ug/L	0.2		ND	0.2		ND	0.2		ND	0.2		ND
BENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND
TOLUENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND
1,3-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND
1,4-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND
ETHYLBENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND
XYLENES	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	10	1	<	10	2	<	10	1	<
DIETHYL PHTHALATE	E625	ug/L	10		ND	10		ND	10	1	<	10		ND
DI-N-BUTYL PHTHALATE	E625	ug/L	10		ND	10		NV	10		ND	10		ND
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10		NV	10	6	<	10	26	=	10	16	=
2,4-DIMETHYLPHENOL	E625	ug/L	10		ND	10		ND	10		ND	10		ND
PHENOL	E625	ug/L	10		ND	10		ND	10		ND	10		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00		ND	1.01	6	=	1.04		ND	1.03		ND
SILVER, TOTAL	E200.7	mg/L	.0100		ND	.0100		ND	.0100		ND	.0100		ND
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050		ND
BORON, TOTAL	E200.7	mg/L	.100	0.18	=	.100	0.431	=	.100	0.467	=	.100	0.511	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.068	=	.0500	0.413	=	.0500	0.117	=	.0500	0.518	=
CALCIUM, TOTAL	E200.7	mg/L	.200	388	=	.200	136	=	.200	26.2	=	.200	184	=
CADMIUM, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050		ND
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND	.0100	0.017	=	.0100		ND	.0100		ND
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND	.0250		ND	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400		NV	.0400		ND	.0400		ND	.0400	0.069	=
POTASSIUM, TOTAL	E200.7	mg/L	5.00	48.4	=	5.00	37.7	=	5.00	122	=	5.00	42.4	=
MAGNESIUM, TOTAL	E200.7	mg/L	.200	38.8	=	.200	64.9	=	.200	39.7	=	.200	77.9	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.315	=	.0100	0.269	=	.0100	0.038	=	.0100	0.616	=
SODIUM, TOTAL	E200.7	mg/L	.900	47.9	=	.900	401	=	.900	455	=	.900	571	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.03	=	.0150	0.077	ND	.0150	0.032	=	.0150	0.059	=
SILICON, TOTAL	E200.7	mg/L	.300	3.93	=	.300	4.78	=	.300	3.96	=	.300	4.97	=
ZINC, TOTAL	E200.7	mg/L	.0100		NV	.0100		ND	.0100		ND	.0100		ND
ALKALINITY	A403	mg/L	10	280	=	10	240	=	10	250	=	10	230	=
COD	A508A	mg/L	5		HT	5	29	=	5	55	=	5	57	=
FLUORIDE	E340.2	mg/L	0.1	0.2	=	0.1	0.3	=	0.1	0.3	=	0.1	0.2	=
NITRATE/NITRITE	E353.1	mg/L	0.1	0.3	ND	0.1	0.1	=	0.1		ND	0.1		ND
AMMONIA	E350.3	mg/L	0.1		HT	0.1		HT	0.1		HT	0.1		HT
TOC	E415.1	mg/L	1.0	8.7	=	1.0	5.4	=	1.0	14	=	1.0	10	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	1800	=	10	2000	=	10	1300	=	10	2200	=
	SAMPLE # RFW # SAMPLE DATE		01-162-M001 8804-009-006 06-APR-88			01-257-M001 8804-092-001 12-APR-88			01-259-M001 8804-092-002 12-APR-88			01-261-M001 8804-092-003 12-APR-88		
CHLORIDE	A429	mg/L	62.5	152	=	125	1820	=	62.5	598	=	125	745	=
SULFATE	A429	mg/L	2.5	36.5	=	25	115	=	2.5	15	=	2.5	9.8	=
	SAMPLE # RFW # SAMPLE DATE		01-162-M021 137192 07-AUG-88			01-257-M021 137188 07-AUG-88			01-259-M021 137202 07-AUG-88			01-261-M021 137190 07-AUG-88		
COD	A508A	mg/L	5	88	=									
AMMONIA	E350.3	mg/L	0.1	0.7	=	0.1	0.5	=	0.1	0.7	=	0.1	1.4	=

DL - SAMPLE DETECTION LIMIT
R - RESULTS
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-30

(CONTINUED)

ANALYTE	METHOD	UNIT	DL	R	QL
	SAMPLE # / RFW # / SAMPLE DATE		01-263-M001 / 128051 / 12-APR-88		
1,1-DICHLOROETHANE	E601	ug/L	0.4		ND
1,2-DICHLOROETHANE	E601	ug/L	0.2		ND
TRANS-1,2-DICHLOROETHENE	E601	ug/L	0.5		ND
DICHLORODIFLUOROMETHANE	E601	ug/L	9		ND
METHYLENE CHLORIDE	E601	ug/L	2		ND
VINYL CHLORIDE	E601	ug/L	0.3		ND
1,1,2,2-TETRACHLOROETHANE	E601	ug/L	0.2		ND
TRICHLOROETHENE	E601	ug/L	0.6		ND
CHLOROFORM	E601	ug/L	0.2		ND
BENZENE	SW5030/SW8020	ug/L	2		ND
TOLUENE	SW5030/SW8020	ug/L	2		ND
1,3-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND
1,4-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND
ETHYLBENZENE	SW5030/SW8020	ug/L	2		ND
XYLENES	SW5030/SW8020	ug/L	5		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10	2	<
DIETHYL PHTHALATE	E625	ug/L	10	1	<
DI-N-BUTYL PHTHALATE	E625	ug/L	10	1	<
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10	15	=
2,4-DIMETHYLPHENOL	E625	ug/L	10		ND
PHENOL	E625	ug/L	10		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.05	2	=
SILVER, TOTAL	E200.7	mg/L	.0100		ND
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND
BORON, TOTAL	E200.7	mg/L	.100	0.524	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.375	=
CALCIUM, TOTAL	E200.7	mg/L	.200		ND
CADMIUM, TOTAL	E200.7	mg/L	.0050	132	=
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND
COPPER, TOTAL	E200.7	mg/L	.0250	0.031	=
IRON, TOTAL	E200.7	mg/L	.0400		ND
POTASSIUM, TOTAL	E200.7	mg/L	5.00	46.1	=
MAGNESIUM, TOTAL	E200.7	mg/L	.200	52.9	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.605	=
SODIUM, TOTAL	E200.7	mg/L	.900	320	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.056	=
SILICON, TOTAL	E200.7	mg/L	.300	4.98	=
ZINC, TOTAL	E200.7	mg/L	.0100	0.02	=
ALKALINITY	A403	mg/L	10	210	=
COD	A508A	mg/L	5	31	=
FLUORIDE	E340.2	mg/L	0.1	0.3	=
NITRATE/NITRITE	E353.1	mg/L	0.1		ND
AMMONIA	E350.3	mg/L	0.1		HT
TOC	E415.1	mg/L	1.0	7.1	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	1400	=
	SAMPLE # / RFW # / SAMPLE DATE		01-263-M001 / 8804-092-004 / 12-APR-88		
CHLORIDE	A429	mg/L	62.5	428	=
SULFATE	A429	mg/L	2.5	6.2	=
	SAMPLE # / RFW # / SAMPLE DATE		01-263-M021 / 137193 / 07-AUG-88		
AMMONIA	E350.3	mg/L	0.1	0.7	=

DL - SAMPLE DETECTION LIMIT
R - RESULTS
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

landfill. Sample 01-158-M001 contained the following purgeable aromatics and halocarbons: benzene (60 ug/L), toluene (650 ug/L), 1,1-dichloroethene (7.9 ug/L), 1,3-dichlorobenzene (93 ug/L), 1,4-dichlorobenzene (9 ug/L), trans-1,2-dichloroethene (650 ug/L), ethylbenzene (92 ug/L), dichlorodifluoromethane (450 ug/L), vinyl chloride (68 ug/L), 1,1,2,2-tetrachloroethane (7.3 ug/L), xylenes (210 ug/L), and methylene chloride (310 ug/L). Semivolatile organics diethyl phthalate (160 ug/L), phenol (240 ug/L), and 2,4-dimethylphenol (80 ug/L) were detected in 01-158-M001, as well as petroleum hydrocarbons (1 mg/L).

Sample 01-124-M001 contained the following purgeable aromatics and halocarbons: benzene (29 ug/L), toluene (240 ug/L), 1,2-dichloroethane (3.1 ug/L), trans-1,2-dichloroethene (29 ug/L), ethylbenzene (5 ug/L), vinyl chloride (2.3 ug/L), and trichloroethene (6.7 ug/L). Semivolatile organics di-n-butyl phthalate (<2 ug/L), phenol (210 ug/L), and 2,4-dimethylphenol (15 ug/L) were detected in sample 01-124-M001.

High metals concentrations, common anions, and indicator parameters were detected in both 01-158-M001 and 01-124-M001. Barium (0.716 mg/L), cadmium (0.047 mg/L), chloride (1.74 mg/L), and sulfate (13.1 mg/L) were detected in 01-158-M001. Sample 01-158-M001 also had high values for alkalinity (1,300 mg/L), COD (7,000 mg/L), TOC (2,000 mg/L), and TDS (2,600 mg/L). The concentrations of COD and TOC were the highest detected on base.

Sample 01-124-M001 contained silver (0.014 mg/L), arsenic (0.01 mg/L), barium (0.765 mg/L), cadmium (0.022 mg/L), nickel (0.057 mg/L), zinc (0.105 mg/L), and chloride (1,810 mg/L). High values of alkalinity (1,300 mg/L), COD (1,800 mg/L), TOC (1,100 mg/L), and TDS (5,900 mg/L) were also detected in this sample.

Other groundwater samples showed some indications of contamination (see Table 4-30), but to a much lesser degree. Methylene chloride was detected in trace concentrations (4 to 6 ug/L) in samples 01-259-M001, 01-261-M001, and 01-257-M001. Common plasticizers bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, and diethyl phthalate were detected in trace concentrations (<1 to 15 ug/L) in samples 01-259-M001, 01-261-M001, 01-263-M001, 01-257-M001, 01-122-M001, and 01-125-M001. Petroleum hydrocarbons were detected in samples 01-160-M001 (5 mg/L) and 01-263-M001 (2 mg/L). Barium was detected (0.058 to 0.765 mg/L) in all samples. Nickel (0.016 to 0.087 mg/L) was detected in every sample except 01-122-M001, 01-158-M001, and 01-160-M001. Chromium was detected in sample 01-257-M001 at 0.017 mg/L.

Among common anions, chloride was detected above secondary drinking water standards (250 mg/L) in samples 01-124-M001 (1,810 mg/L), 01-259-M001 (598 mg/L), 01-261-M001 (745 mg/L), 01-263-M001 (428 mg/L), 01-257-M001 (1,820 mg/L), 01-123-M001 (297 mg/L), and 01-156-M001 (342 mg/L). Sulfate was detected

above secondary drinking water standards (250 mg/L) in sample 01-122-M001 (475 mg/L). Above-background values of alkalinity were detected in samples 01-122-M001 (900 mg/L), 01-122-M101 (670 mg/L), 01-124-M001 (1,300 mg/L), 01-158-M001 (1,300 mg/L), and 01-125-M001 (2,500 mg/L). COD was detected at 380 mg/L in sample 01-156-M001 and at 480 mg/L in sample 01-123-M001. TDS values were elevated for every sample (880 to 2,600 mg/L) except 01-160-M001 (560 mg/L).

4.4.2.3 Chemical Results for Surface Water -- SWLF

Five surface water stations were established at SWLF. One station (01-504) was placed in the pump house on the southwestern edge of SWLF. Two other stations (01-501 and 01-503) were placed in ponds in the SWLF. Station 01-505 was established by Taxiway C at a storm sewer manhole. One duplicate and five investigative surface water samples were collected on 20 April 1988 after an extended dry period, and one duplicate and five investigative surface water samples were collected on 10 May 1988 after a significant rain event.

All surface water samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, COD, TOC, alkalinity, and TDS. Holding times were exceeded for all TDS analyses for all dry-event surface water samples and for COD samples for wet-event samples 01-501-W002, 01-503-W002, 01-503-W102, and 01-505-W002. These results were not valid; therefore, the surface water stations were resampled on 3 August (wet event) and on 8 August 1988 (dry event) for these parameters. Surface water stations 01-501 and 01-503 were dry during both resampling events and could not be resampled.

Surrogate recoveries for purgeable halocarbons ranged from 74 to 159 percent and matrix spike recoveries from 91 to 107 percent. Surrogate recoveries for purgeable aromatics ranged from 65 to 101 percent and matrix spike recoveries from 80 to 86 percent. Semivolatile surrogate recoveries ranged from 12 to 153 percent and matrix spike recoveries from 37 to 126 percent. Metals screen matrix spike recoveries ranged from 21.4 to 105 percent. All surrogate recoveries and matrix spike recoveries were within quality control limits.

Table 4-31 lists the valid analytes and concentrations detected in surface water collected at SWLF. Surface water station 01-501 exhibited the greatest degree of contamination. It contained trichlorofluoromethane (90 to 150 ug/L) during both sampling rounds and 4-nitrophenol (<12 ug/L), pentachlorophenol (<7 ug/L), and phenol (<9 mg/L) during the wet event. Barium (0.518 mg/L) arsenic (0.032 mg/L), cadmium (0.066 mg/L), chromium (0.022 mg/L), copper (0.032 mg/L), nickel (0.053 mg/L), and

TABLE 4-31

VALID ANALYTES DETECTED IN DRY-EVENT SURFACE WATER AT SWLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

ANALYTE	SAMPLE # / RFW # / SAMPLE DATE		01-501-W001 128914 20-APR-88			01-502-W001 128915 20-APR-88			01-503-W001 128916 20-APR-88			01-503-W101 128917 20-APR-88			01-504-W001 128920 20-APR-88			01-505-W001 128921 20-APR-88		
	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
TRICHLOROFLUOROMETHANE	E601	ug/L	5	150 (96)	=	5		ND	5		ND	5		ND	5		ND	5		ND
METHYLENE CHLORIDE	E601	ug/L	2		ND	2		ND	2		ND	2		ND	2		ND	2		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10	6	<	10		ND
DIETHYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND	10		ND
DI-N-BUTYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND	10		ND
4-NITROPHENOL	E625	ug/L	50		ND	50		ND	50		ND	50		ND	50		ND	50		ND
PENTACHLOROPHENOL	E625	ug/L	50		ND	50		ND	50		ND	50		ND	50		ND	50		ND
PHENOL	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND	10		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.20	2.4	=	1.04	1.3	=	1.03		ND	1.04		ND	1.04	1.1	=	1.02		ND
ALUMINUM, TOTAL	E200.7	mg/L	.200	9.27	=	.200	0.505	=	.200		ND	.200		ND	.200		ND	.200		ND
ARSENIC, TOTAL	E200.7	mg/L	.0250	0.032	=	.0500		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND
BORON, TOTAL	E200.7	mg/L	.100	0.942	=	.100	0.136	=	.100	0.248	=	.100	0.13	=	.100		ND	.100		ND
BARIUM, TOTAL	E200.7	mg/L	.0500	0.518	=	.0500	0.069	=	.0500	0.101	=	.0500	0.054	=	.0500		ND	.0500		ND
CALCIUM, TOTAL	E200.7	mg/L	.200	449	=	.200	118	=	.200	183	=	.200	96.5	=	.200	96.3	=	.200	82.4	=
CADMIUM, TOTAL	E200.7	mg/L	.0050	0.066	=	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND
CHROMIUM, TOTAL	E200.7	mg/L	.0100	0.022	=	.0100	0.017	=	.0100		ND	.0100		ND	.0100		ND	.0100		ND
COPPER, TOTAL	E200.7	mg/L	.0250	0.032	=	.0250		ND	.0250	0.03	=	.0250		ND	.0250		ND	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400	44.9	=	.0400	1.29	=	.0400	0.708	=	.0400	0.445	=	.0400	0.425	=	.0400		NV
POTASSIUM, TOTAL	E200.7	mg/L	5.00	34	=	5.00		ND	5.00	10.9	=	5.00	6.06	=	5.00		ND	5.00		ND
MAGNESIUM, TOTAL	E200.7	mg/L	.200	146	=	.200	36.6	=	.200	41.8	=	.200	22.2	=	.200	27.6	=	.200	21.2	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	7.57	=	.0100	0.259	=	.0100	0.028	=	.0100	0.016	=	.0100	0.111	=	.0100	0.021	=
SODIUM, TOTAL	E200.7	mg/L	.900	251	=	.900	93.5	=	.900	29.3	=	.900	16.5	=	.900	101	=	.900	7.52	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.053	=	.0150		ND	.0150		ND	.0150		ND	.0150		ND	.0150		ND
LEAD, TOTAL	E200.7	mg/L	.0100		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND
SILICON, TOTAL	E200.7	mg/L	.300	24.2	=	.300	2.39	=	.300	7.77	=	.300	4.32	=	.300	2.53	=	.300	3.06	=
ZINC, TOTAL	E200.7	mg/L	.0100	0.44	=	.0100		NV	.0100		NV	.0100		NV	.0100		NV	.0100		ND
ALKALINITY	A403	mg/L	10	570	=	10	360	=	10	340	=	10	360	=	10	320	=	10	390	=
COD	A508A	mg/L	5	390	=	5	41	=	5	50	=	5	50	=	5	22	=	5	10	=
FLUORIDE	E340.2	mg/L	0.1	0.2	=	0.1	0.2	=	0.1	0.2	=	0.1	0.2	=	0.1	0.1	=	0.1	0.2	=
NITRATE/NITRITE	E353.1	mg/L	0.1	0.2	=	0.1		ND	0.1		ND	0.1		ND	0.1	0.7	=	0.1	0.4	=
AMMONIA	E350.3	mg/L	0.1	0.4	=	0.1	0.2	=	0.1	0.2	=	0.1	0.3	=	0.1	0.1	=	0.1	0.1	=
TOC	E415.1	mg/L	5	52	=	1.0	11	=	1.0	17	=	1.0	17	=	1.0	6.6	=	1.0	4	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT	10		HT	10		HT
	SAMPLE # / RFW # / SAMPLE DATE		01-501-W001 8804-183-014 20-APR-88			01-502-W001 8804-183-015 20-APR-88			01-503-W001 8804-183-011 20-APR-88			01-503-W101 8804-183-012 20-APR-88			01-504-W001 8804-183-016 20-APR-88			01-505-W001 8804-183-041 20-APR-88		
CHLORIDE	A429	mg/L	2.5	22.5	=	25	186	=	2.5	29.4	=	2.5	30.5	=	25	97.6	=	2.5	4.8	=
SULFATE	A429	mg/L	25	199	=	25	100	=	2.5	26.6	=	2.5	27.6	=	25	33.9	=	2.5	10.7	=
	SAMPLE # / RFW # / SAMPLE DATE		501 STATION DRY 08-AUG-88			01-502-W021 137305 08-AUG-88			503 STATION DRY 08-AUG-88			01-504-W121 137301 08-AUG-88			01-504-W021 137300 08-AUG-88			01-505-W001 137306 08-AUG-88		
TOTAL DISSOLVED SOLIDS	E160.1	mg/L				10	540	=				10	320	=	10	310	=	10	270	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBER IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-31 (CONTINUED)

VALID ANALYTES DETECTED IN WET-EVENT SURFACE WATER AT SWLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE		01-501-W002 / 130178 / 10-MAY-88			01-502-W002 / 130179 / 10-MAY-88			01-503-W002 / 130180 / 10-MAY-88			01-503-W102 / 130181 / 10-MAY-88			01-504-W002 / 130184 / 10-MAY-88			01-505-W002 / 130187 / 10-MAY-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
TRICHLOROFLUOROMETHANE	E601	ug/L	5	70 (90)	=	5		ND	5		ND	5		ND	5		ND	5		ND
METHYLENE CHLORIDE	E601	ug/L	2		ND	2		ND	2	2	=	2		ND	2		ND	2		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND	9		ND
DIETHYL PHTHALATE	E625	ug/L	10	6	<	10		ND	10		ND	10		ND	10		ND	9		ND
DI-N-BUTYL PHTHALATE	E625	ug/L	10	1	<	10	1	<	10		ND	10	2	<	10		ND	9		ND
4-NITROPHENOL	E625	ug/L	50	12	<	50		ND	50		ND	50		ND	50		ND	44		ND
PENTACHLOROPHENOL	E625	ug/L	50	7	<	50		ND	50		ND	50		ND	50		ND	44		ND
PHENOL	E625	ug/L	10	9	<	10		ND	10		ND	10		ND	10		ND	9		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.02		NV	1.11		ND	1.08		NV	1.08		NV	1.04		NV	1.12		NV
ALUMINUM, TOTAL	E200.7	mg/L	.200	1.97	=	.200	0.772	=	.200		ND	.200	0.254	=	.200		ND	.200		ND
ARSENIC, TOTAL	E200.7	mg/L	.0500		ND	.0100		ND	.0050	0.005	=	.0050	0.006	=	.0050		ND	.0050		ND
BORON, TOTAL	E200.7	mg/L	.100	0.569	=	.100	0.195	=	.100	0.139	=	.100	0.116	=	.100		ND	.100		ND
BARIUM, TOTAL	E200.7	mg/L	.0500	0.28	=	.0500	0.11	=	.0500	0.06	=	.0500		ND	.0500		ND	.0500		ND
CALCIUM, TOTAL	E200.7	mg/L	.200	222	=	.200	130	=	.200	70.6	=	.200	62.3	=	.200	102	=	.200	86.6	=
CADMIUM, TOTAL	E200.7	mg/L	.0050	0.005	=	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND	.0100	0.017	=	.0100		ND	.0100		ND	.0100		ND	.0100		ND
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND	.0250		NV	.0250		ND	.0250		ND	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400	21.2	=	.0400	3.24	=	.0400	1.01	=	.0400	1.13	=	.0400	0.505	=	.0400	0.181	=
POTASSIUM, TOTAL	E200.7	mg/L	5.00	26.9	=	5.00	5.89	=	5.00	8.79	=	5.00	8.54	=	5.00		ND	5.00		ND
MAGNESIUM, TOTAL	E200.7	mg/L	.200	85.7	=	.200	46.8	=	.200	26.1	=	.200	26.2	=	.200	31.7	=	.200	23.1	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	3.42	=	.0100	2.11	=	.0100	0.175	=	.0100	0.124	=	.0100	0.262	=	.0100	0.043	=
SODIUM, TOTAL	E200.7	mg/L	.900	193	=	.900	156	=	.900	20	=	.900	20.8	=	.900	93.1	=	.900	8.97	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.021	=	.0150		ND	.0150		ND	.0150		ND	.0150		ND	.0150		ND
LEAD, TOTAL	E200.7	mg/L	.0100		ND	.0050	0.005	=	.0050		ND	.0050		ND	.0050		ND	.0050		ND
SILICON, TOTAL	E200.7	mg/L	.300	13.8	=	.300	4.13	=	.300	3.68	=	.300	3.57	=	.300	3.63	=	.300	3.69	=
ZINC, TOTAL	E200.7	mg/L	.0100	0.242	=	.0100	0.148	=	.0100	0.07	=	.0100		NV	.0100		NV	.0100		NV
ALKALINITY	A403	mg/L	10	680	=	10	390	=	10	290	=	10	310	=	10	300	=	10	260	=
COD	A508A	mg/L	5		HT	5	60	=	5		HT	5		HT	5	31	=	5		HT
FLUORIDE	E340.2	mg/L	0.1	0.3	=	0.1	0.2	=	0.1	0.2	=	0.1	0.2	=	0.1	0.2	=	0.1	0.3	=
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1		ND	0.1		ND	0.1	0.1	=	0.1	1.1	=	0.1	0.6	=
AMMONIA	E350.3	mg/L	0.1	0.2	=	0.1		ND	0.1	0.2	=	0.1	0.2	=	0.1		ND	0.1		ND
TOC	E415.1	mg/L	20	100	=	2	16	=	5	34	=	2	31	=	1.0	6.1	=	1.0	4.7	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	1400	=	10	990	=	10	380	=	10	340	=	10	600	=	10	380	=
	SAMPLE # / RFW # / SAMPLE DATE		01-501-W002 / 8805-386-026 / 10-MAY-88			01-502-W002 / 8805-386-027 / 10-MAY-88			01-503-W002 / 8805-386-001 / 10-MAY-88			01-503-W102 / 8805-386-002 / 10-MAY-88			01-504-W002 / 8805-386-029 / 10-MAY-88			01-505-W002 / 8805-386-004 / 10-MAY-88		
CHLORIDE	A429	mg/L	62.5	328	=	62.5	308	=	2.5	43.7	=	2.5	39.7	=	62.5	145	=	2.5	16.3	=
SULFATE	A429	mg/L	62.5	92.5	=	2.5	54.3	=	2.5	6.4	=	2.5	7.4	=	2.5	49.8	=	325	325	=
	SAMPLE # / RFW # / SAMPLE DATE		501 STATION DRY / 03-AUG-88						503 STATION DRY / 03-AUG-88									01-505-W021 / 136818 / 03-AUG-88		
COD	A508A	mg/L																5	11	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBER IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

zinc (0.440 mg/L) were detected at surface water station 01-501 during the dry event. Alkalinity (680 mg/L), COD (390 mg/L), TOC (100 mg/L), and TDS (1,400 mg/L) were present at above-background concentrations at station 01-501.

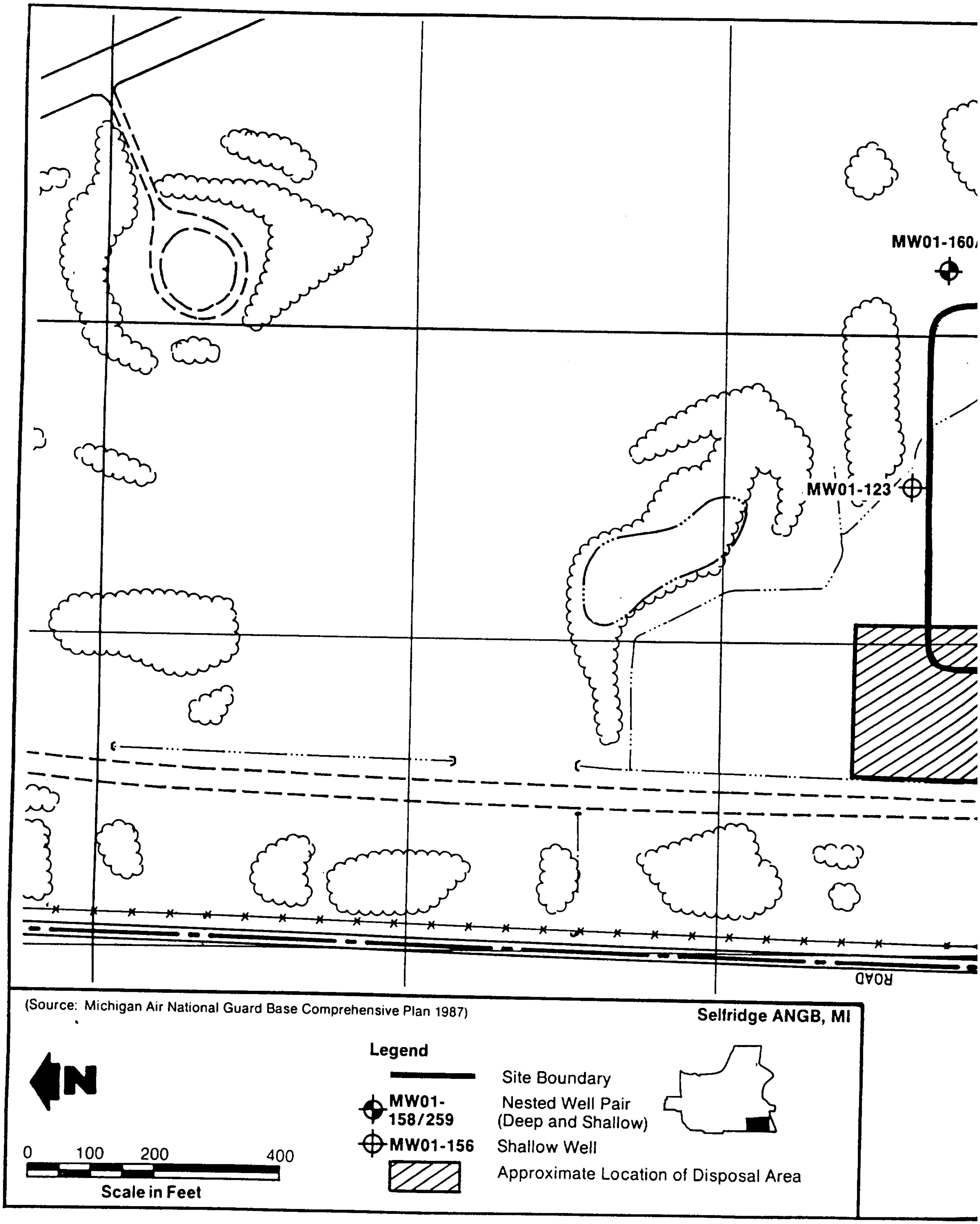
Station 01-502 during the wet event contained barium (0.11 mg/L), chromium (0.017 mg/L), zinc (0.148 mg/L), and lead (0.005 mg/L). Station 01-503 contained arsenic (0.005 mg/L) and COD (50 mg/L). All other analyses were within background ranges.

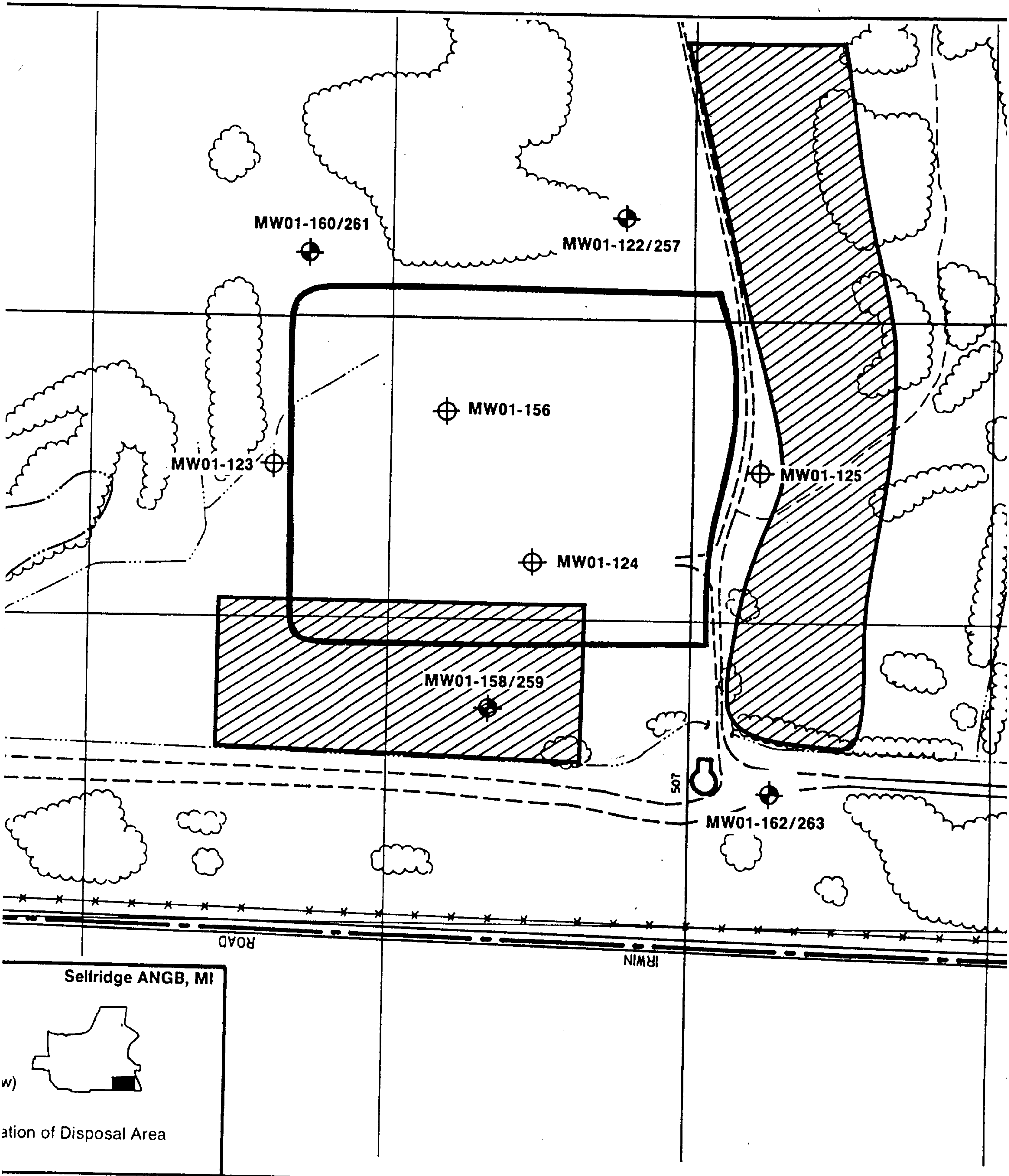
4.4.3 Extent of Contamination -- SWLF

The IRP Stage 2 study at SWLF involved investigation of the site as defined by the boundary line shown in Figure 3-3. During the installation of monitor well nest 01-158/259 landfill waste was encountered at depths of 1.5 to 10.3 feet BLS. This location was outside the originally defined boundary of the site. A subsequent examination of historical aerial photographs revealed two additional areas used for waste disposal in the vicinity of the SWLF site. Based upon the times the photographs were taken, both areas pre-date the site currently under study. Neither of these areas was examined for extent of contamination during this study.

The older of the newly discovered disposal areas is located to the south of the SWLF site. This disposal site constitutes the area mapped by the USDA Soil Survey as sanitary landfill and sand pit, as depicted in Figure 2-5. The other newly discovered area is between Perimeter Road and SWLF. Approximately six east-west trenches are visible in aerial photographs. Well nest 01-158/259 is situated within one of these trenches. The trenches are believed to have been backfilled with waste material, based upon debris encountered during the installation of the monitor well nest. Figure 4-33 shows the locations of these two disposal sites, based upon the historical aerial photographs and USDA Soil Survey map. Neither of these two disposal sites was explicitly examined by the field investigation performed for this study; however, some contaminant information about the six east-west trenches west of the site is available from soil and groundwater samples taken from monitor well nest 01-158/259.

No soil samples were collected at SWLF during the previous Phase II Stage 1 investigation. Four soil samples were collected in soil borings drilled at SWLF during the IRP Stage 2 investigation, one upgradient of the buried fill (01-363-B001), two downgradient of the buried fill (01-357-B001 and 01-361-B001), and one below the buried fill (01-359-B001). Soil sample 01-359-B001 was the most contaminated soil sample collected at SWLF. It contained petroleum hydrocarbons, acetone, 1,2-dichloroethene, 2-butanone, 4-methyl-2-pentanone, toluene, diethyl ether, and phenol. Concentrations of these contaminants


MW01-160/
MW01-123
ROAD
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0
100
200
400
Scale in Feet
Legend
Site Boundary
MW01-
158/259
Nested Well Pair
(Deep and Shallow)
MW01-156
Shallow Well
Approximate Location of Disposal Area



MW01-160/261
MW01-122/257
MW01-156
MW01-123
MW01-125
MW01-124
MW01-158/259
507
MW01-162/263
ROAD
IRWIN
Selfridge ANGB, MI
w)
ation of Disposal Area

FIGURE 4-33

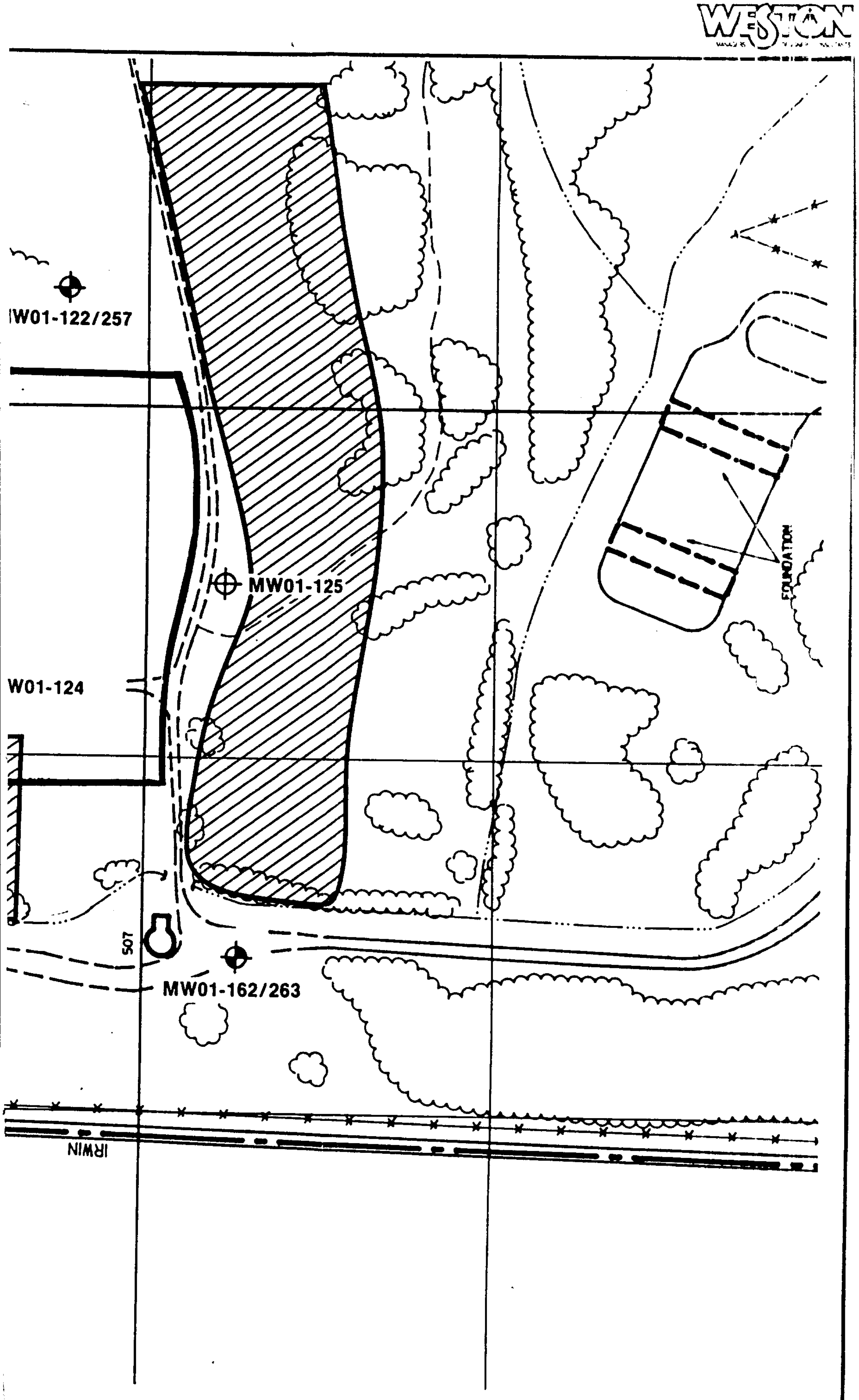


FIGURE 4-33 ADDITIONAL DISPOSAL AREAS IDENTIFIED DURING THE IRP STAGE 2 STUDY AT SWLF

are presented in Table 4-29. The only detection of mercury during the IRP Stage 2 investigation occurred in this soil sample.

Soil samples upgradient of SWLF (01-363-B001) contained petroleum hydrocarbons, acetone, and nickel. The nickel concentration was the highest detected on base. The presence of these contaminants in a "background" sample suggests that waste disposal may have occurred in the area west of the pump house. One of the soil samples downgradient of the fill (01-357-B001) contained several semivolatile compounds in trace concentrations (<0.03 to <0.20 mg/kg). The semivolatiles are typical of coal tar or wood preservatives and suggest the presence of buried railroad ties or asphalt. This soil sample also contained lead, one of two soil samples collected on base to contain this element. The other downgradient sample (01-361- B001) contained acetone.

It can be concluded from the soil samples that the soil directly below the buried waste is indeed affected by waste disposal and is probably a recipient of contamination via downward migration of contaminated interstitial water from the waste. The downgradient and upgradient soil samples suggest that the contamination has spread beyond the boundaries of the fill, but to what extent and to what degree are unknown. The presence of contamination in the upgradient soils indicates that the extent of landfill activity and groundwater and surface water migration at this site is poorly understood.

Four monitor wells were installed and sampled at SWLF during the Phase II Stage 1 investigation. The Stage 1 report indicates that monitor well 01-124 contained the most contamination, including benzene, trans-1,2-dichloroethene, ethylbenzene, methylene chloride, toluene, trichloroethene, and vinyl chloride in concentrations of 6.7 to 84 ug/L. This well also contained high COD (3,150 mg/L), petroleum hydrocarbons (113 mg/L), TOC (1,670 mg/L), copper (1.1 mg/L), and total phenolics (435 ug/L). Of the other monitor wells sampled, only 01-125 contained volatile organics (2 ug/L 1,2-trans-dichloroethene). Monitor well 01-125 also contained petroleum hydrocarbons (0.8 mg/L). Monitor well 01-123 contained oil and grease (1.38 mg/L), lead (0.020 mg/L), and phenolics (5 ug/L).

The IRP Stage 2 investigation installed 8 additional monitor wells and sampled all 12. The sample from 01-158, which was installed in buried waste, contained the most contaminants, including solvents (3.9 to 650 ug/L), petroleum hydrocarbons (1 mg/L), and high values of TDS, COD, TOC, and alkalinity. Monitor well 01-124, the most contaminated well during the Phase II Stage 1 investigation, contained contaminants, similar to those in monitor well 01-158 in slightly lower concentrations. The remaining monitor wells showed some low-level contamination of volatile organics, but all had generally elevated values of TDS.

In addition, monitor well 01-257 contained elevated chloride concentrations, and monitor wells 01-122 and 01-125 contained elevated alkalinity. Copper and lead were not detected in any monitor wells during the Stage 2 investigation, but cadmium was detected in monitor well 01-158 (0.047 mg/L) in concentrations above drinking water standards.

Potentiometric maps for SWLF show that, in general, a potentiometric high exists in the western part of the site, with groundwater moving away from that high in a radial pattern north, east, and south. Thus, monitor well 01-158 is directly upgradient of monitor well 01-124, indicating that 01-124 may be receiving diluted leachate from the waste trench in which 01-158 is installed. This would account for the similar suite of contaminants. The radial pattern shifts with seasonal adjustments. During August 1988 monitor well nest 01-162/263 was downgradient from monitor well 01-158, which may account for the presence of some contaminants in the soil at 01-263. Because of these seasonal adjustments, contaminants may migrate in almost all directions from the potentiometric high centered in the western part of the landfill.

Shallow groundwater velocities at SWFL were relatively high for the base. Calculated rates were 244 and 609 ft/year for the shallow monitor wells on 21 March and 1 August 1988, respectively. Rates were 3.15 ft/year on 21 March and 6.28 ft/year on 1 August 1988 for the deep monitor wells (see Subsection 4.4.1.3). Based upon the distribution coefficient of benzene, a soil carbon content of 0.1 percent, and a soil porosity of 15 percent, the retardation equation (see Subsection 4.2.2.4) was used to calculate a maximum migration velocity of the contaminants to be 296.9 ft/year for shallow wells. If a carbon content of 1.0 percent is used in the retardation equation with the slower velocity rate of 244 ft/year for groundwater, the migration rate adjusts to 21.2 ft/year for shallow wells. The deep wells migration rate calculates to be 3.06 ft/year and 0.27 ft/year. As SWLF has been used since 1970, the calculated maximum migration of the contaminant plume would be approximately 5,344 feet. This would place the leading edge of the plume well beyond the U.S. Army Area, North River Road, and possibly approaching the Clinton River in an east-southeasterly direction.

Surface water samples were obtained during the Phase II Stage 1 investigation from three ponds of standing water in front of the fill face. Low levels of copper (0.013 to 0.034 mg/L), total phenolics (29 and 47 mg/L), and oil and grease (0.1 and 0.2 mg/L) were detected in these samples. Volatile organic analyses of these samples were invalidated because of exceeded holding times.

The IRP Stage 2 investigation sampled two surface impoundments (01-501 and 01-503) in locations similar to the impoundments

sampled during the Phase II Stage 1 investigation. The drainage ditch that meanders around SWLF was sampled (01-502), and the stormwater drainage system was sampled at an upgradient catch basin (01-505) and at the downgradient pump station (01-504). The upgradient catch basin samples were not contaminated. The pump station sample contained petroleum hydrocarbons (1.1 mg/L) in the dry-event sample. No contaminants were detected in the drainage ditch, and only low levels were found in the impoundments. Both contained low levels of petroleum hydrocarbons (1.3 to 2.4 mg/L). Low levels (90 to 150 ug/L) of the common refrigerant trichlorofluoromethane occurred in both dry and wet sampling events of station 01-501. Arsenic, barium, cadmium, chromium, copper, nickel, and zinc occurred in dry- and wet-event samples from station 01-501, and the concentration of cadmium (0.066 mg/L) was above drinking water standards.

Examination of the basewide groundwater and surface water maps clearly shows that a major portion of the groundwater at SWLF is moving northeast to a depression caused by interception of the groundwater by the stormwater drainage system. This indicates that the contaminated groundwater flowing northeast as well as surface drainage caught by the drainage ditch could be transported to the Clinton River by way of the pump station. Although the pump station water did not appear to be contaminated to any great extent, this is probably due to the limited sampling times and the dilution factor.

No analytes exceeding applicable standards were detected in soil at SWLF. Groundwater samples at SWLF contained butyl benzyl phthalate, diethyl phthalate, di-n-butyl phthalate, bis-(2-ethylhexyl) phthalate, 2,4-dimethylphenol, and phenol at levels exceeding the potential international chemical-specific ARAR standards.

Vinyl chloride, 1,1,2,2-tetrachloroethane, trichloroethene, benzene, and 1,2-dichloroethane were found to exceed standards for potential international chemical-specific ARARs, RCRA Maximum Contaminant Level (MCL), EPA ambient water quality criteria, and Safe Drinking Water Act standards.

Cadmium, copper, iron, nickel, and zinc were detected at levels exceeding the potential international chemical-specific ARARs. Cadmium concentrations also exceeded the RCRA Maximum Contaminant Level standards, Clean Water Act freshwater toxicity criteria, EPA ambient water quality criteria, and the Safe Drinking Water Act. Concentrations of nickel were in exceedance of EPA ambient water quality criteria.

Ammonia and TDS were detected in all groundwater from SWLF at levels exceeding the potential international chemical-specific ARAR standards. The concentration range for ammonia was between 0.6 and 12 mg/L. The concentration for TDS was between

560 and 5,900 mg/L. Refer to Table 4-32 for exact concentrations and regulation exceedances.

Butyl benzyl phthalate, diethyl phthalate, di-n-butyl phthalate, 4-nitrophenol, pentachlorophenol, and phenol were all detected at SWLF exceeding the potential international chemical-specific ARAR standards during both wet and dry surface water sampling events.

Cadmium, copper, iron, and zinc were detected at SWLF to exceed the potential international chemical-specific ARAR standards during both wet and dry surface water sampling events. Concentrations of arsenic in surface water exceeded the potential international chemical-specific ARARs, EPA ambient water quality criteria, and Safe Drinking Water Act standards. Surface water sample 01-501 for both wet and dry sampling events exceeded several standards (see Table 4-33). Concentrations of copper detected were in exceedance of potential international chemical-specific ARARs and Clean Water Act freshwater toxicity criterion standards.

TDS exceeded the potential international chemical-specific ARARs for every sample at SWLF. The range of concentration was between 270 and 1,400 mg/L. Refer to Table 4-33 for exact concentrations and regulation exceedances.

4.4.4 Qualitative Risk Assessment -- SWLF

The SWLF site has relatively extensive contamination of groundwater and surface and subsurface soils. Seventy-four individual chemical species were detected at this site. In order to focus an evaluation of the hazard on the highest-risk chemicals present at the site, the indicator chemical selection process outlined by the EPA (1986) was used to identify the site-specific contaminants of concern. The contaminants of concern identified for the SWLF site are listed in Table 4-34.

The following potential migration pathways for movement of contaminants from SWLF have been identified:

- Soil/waste --> surface water
- Soil/waste --> groundwater
- Soil/waste --> groundwater --> stormwater drainage system --> surface water
- Soil/waste --> air

According to base records there are approximately 25 to 100 persons within 1,000 feet of the site perimeter on a day-to-day basis. A barrier exists on the road leading to SWLF, but access to the site is not restricted; however, SWLF is fairly remote, and direct contact with contaminated site media by base personnel is considered unlikely.

Table 4-32

Analyte Concentrations in SWLF Groundwater Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Vinyl chloride		N/A	N/A	2×10^{-3}	N/A	N/A	2×10^{-2}
01-124-M001	2.3×10^{-3}	---	---	X	---	---	---
01-158-M001	6.8×10^{-2}	---	---	X	---	---	X
1,1,2,2-Tetra-chloroethane		N/A	1.8×10^{-5}	N/A	N/A	N/A	1.7×10^{-3}
01-158-M001	7.3×10^{-3}	---	X	---	---	---	X
Trichloroethene		N/A	3.2×10^{-4}	N/A	N/A	N/A	2.7×10^{-2}
01-124-M001	6.7×10^{-3}	---	X	---	---	---	---
01-158-M001	1.7×10^{-1}	---	X	---	---	---	X
Benzene		N/A	N/A	5×10^{-3}	N/A	N/A	6.6×10^{-3}
01-124-M001	2.9×10^{-2}	---	---	X	---	---	X
01-158-M001	6.0×10^{-2}	---	---	X	---	---	X
1,2 Dichloroethane		N/A	3.8×10^{-5}	N/A	N/A	N/A	N/A
01-124-M001	3.1×10^{-3}	---	X	---	---	---	---
Butyl benzyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
01-257-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
01-259-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
01-261-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
01-263-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-32
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Vinyl chloride		2.8×10^{-2}	2×10^{-3}	0	N/A	N/A
01-124-M001	2.3×10^{-3}	---	X	X	---	---
01-158-M001	6.8×10^{-2}	X	X	X	---	---
1,1,2,2-Tetra-chloroethane		1.7×10^{-3}	N/A	N/A	N/A	N/A
01-158-M001	7.3×10^{-3}	X	---	---	---	---
Trichloroethene		2.8×10^{-2}	N/A	0	N/A	N/A
01-124-M001	6.7×10^{-3}	---	---	X	---	---
01-158-M001	1.7×10^{-1}	X	---	X	---	---
Benzene		6.7×10^{-3}	5×10^{-3}	0	---	0
01-124-M001	2.9×10^{-2}	X	X	X	---	X
01-158-M001	6.0×10^{-2}	X	X	X	---	X
1,2 Dichloroethane		N/A	N/A	0	N/A	N/A
01-124-M001	3.1×10^{-3}	---	---	X	---	---
Butyl benzyl phthalate		N/A	N/A	N/A	N/A	N/A
01-257-M001	$<1 \times 10^{-3}$	---	---	---	---	---
01-259-M001	$<2 \times 10^{-3}$	---	---	---	---	---
01-261-M001	$<1 \times 10^{-3}$	---	---	---	---	---
01-263-M001	$<2 \times 10^{-3}$	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-32
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Diethyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
01-158-M001	1.6×10^{-2}	X	---	---	---	---	---
01-259-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
01-263-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
Di-n-butyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
01-122-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
01-124-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
01-125-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
01-158-M001	$<1 \times 10^{-2}$	X	---	---	---	---	---
01-263-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
Bis(2-ethylhexyl) phthalate		6×10^{-4}	N/A	N/A	N/A	N/A	N/A
01-160-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
01-257-M001	$<6 \times 10^{-3}$	X	---	---	---	---	---
01-259-M001	2.6×10^{-2}	X	---	---	---	---	---
01-261-M001	1.6×10^{-2}	X	---	---	---	---	---
01-263-M001	1.5×10^{-2}	X	---	---	---	---	---
2,4-Dimethylphenol		1×10^{-3}	N/A	N/A	N/A	N/A	N/A
01-124-M001	1.5×10^{-2}	X	---	---	---	---	---
01-158-M001	8.0×10^{-2}	X	---	---	---	---	---
Phenol		1×10^{-3}	N/A	N/A	N/A	N/A	N/A
01-124-M001	2.1×10^{-1}	X	---	---	---	---	---
01-158-M001	2.4×10^{-1}	X	---	---	---	---	---
Arsenic		N/A	N/A	N/A	N/A	N/A	2.2×10^{-5}
01-124-M001	1.0×10^{-2}	---	---	---	---	---	X

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/l)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/l)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-32
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Diethyl phthalate		N/A	N/A	N/A	N/A	N/A
01-158-M001	1.6×10^{-2}	---	---	---	---	---
01-259-M001	$<1 \times 10^{-3}$	---	---	---	---	---
01-263-M001	$<1 \times 10^{-3}$	---	---	---	---	---
Di-n-butyl phthalate		N/A	N/A	N/A	N/A	N/A
01-122-M001	$<2 \times 10^{-3}$	---	---	---	---	---
01-124-M001	$<2 \times 10^{-3}$	---	---	---	---	---
01-125-M001	$<2 \times 10^{-3}$	---	---	---	---	---
01-158-M001	$<1 \times 10^{-2}$	---	---	---	---	---
01-263-M001	$<1 \times 10^{-3}$	---	---	---	---	---
Bis(2-ethylhexyl) phthalate		N/A	N/A	N/A	N/A	N/A
01-160-M001	$<2 \times 10^{-3}$	---	---	---	---	---
01-257-M001	$<6 \times 10^{-3}$	---	---	---	---	---
01-259-M001	2.6×10^{-2}	---	---	---	---	---
01-261-M001	1.6×10^{-2}	---	---	---	---	---
01-263-M001	1.5×10^{-2}	---	---	---	---	---
2,4-Dimethylphenol		N/A	N/A	N/A	N/A	N/A
01-158-M001	8.0×10^{-2}	---	---	---	---	---
01-124-M001	1.5×10^{-2}	---	---	---	---	---
Phenol		N/A	N/A	N/A	N/A	N/A
01-124-M001	2.1×10^{-1}	---	---	---	---	---
01-158-M001	2.4×10^{-1}	---	---	---	---	---
Arsenic		2.5×10^{-5}	N/A	N/A	N/A	N/A
01-124-M001	1.0×10^{-2}	X	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-32
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Cadmium		2×10^{-4}	N/A	1.0×10^{-2}	3.9×10^{-3}	1.1×10^{-3}	1×10^{-2}
01-124-M001	2.2×10^{-2}	X	---	X	X	X	X
01-158-M001	4.7×10^{-2}	X	---	X	X	X	X
01-263-M001	1.32×10^{-2}	X	---	X	X	X	X
Copper		5×10^{-3}	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A	N/A
01-263-M001	3.1×10^{-2}	X	---	X	X	---	---
Iron		3×10^{-1}	N/A	N/A	N/A	N/A	N/A
01-122-M001	1.02	X	---	---	---	---	---
01-122-M101	6.88×10^{-1}	X	---	---	---	---	---
01-124-M001	8.16×10^{1}	X	---	---	---	---	---
01-158-M001	7.0×10^{2}	X	---	---	---	---	---
01-261-M001	6.9×10^{-2}	X	---	---	---	---	---
Nickel		2.5×10^{-2}	N/A	N/A	N/A	N/A	1.34×10^{-2}
01-124-M001	5.7×10^{-2}	X	---	---	---	---	X
01-125-M001	1.8×10^{-2}	---	---	---	---	---	X
01-156-M001	8.7×10^{-2}	X	---	---	---	---	X
01-162-M001	3×10^{-2}	X	---	---	---	---	X
01-257-M001	7.7×10^{-2}	X	---	---	---	---	X
01-259-M001	3.2×10^{-2}	X	---	---	---	---	X
01-261-M001	5.9×10^{-2}	X	---	---	---	---	X
01-263-M001	5.6×10^{-2}	X	---	---	---	---	X
Zinc		3×10^{-2}	N/A	N/A	N/A	N/A	N/A
01-124-M001	1.05×10^{-1}	X	---	---	---	---	---
01-158-M001	1.74	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-32
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Cadmium		1.2×10^{-2}	1.0×10^{-2}	N/A	5×10^{-3}	5×10^{-3}
01-124-M001	2.2×10^{-2}	X	X	---	X	X
01-158-M001	4.7×10^{-2}	X	X	---	X	X
01-263-M001	1.32×10^{-2}	X	X	---	X	X
Copper		N/A	N/A	N/A	N/A	N/A
01-263-M001	3.1×10^{-2}	---	---	---	---	---
Iron		N/A	N/A	N/A	N/A	N/A
01-122-M001	1.02	---	---	---	---	---
01-122-M101	6.88×10^{-1}	---	---	---	---	---
01-124-M001	8.16×10^{1}	---	---	---	---	---
01-158-M001	7.0×10^{2}	---	---	---	---	---
01-261-M001	6.9×10^{-2}	---	---	---	---	---
Nickel		1.54×10^{-2}	N/A	N/A	N/A	N/A
01-124-M001	5.7×10^{-2}	X	---	---	---	---
01-125-M001	1.8×10^{-2}	X	---	---	---	---
01-156-M001	8.7×10^{-2}	X	---	---	---	---
01-162-M001	3×10^{-2}	X	---	---	---	---
01-257-M001	7.7×10^{-2}	X	---	---	---	---
01-259-M001	3.2×10^{-2}	X	---	---	---	---
01-261-M001	5.9×10^{-2}	X	---	---	---	---
01-263-M001	5.6×10^{-2}	X	---	---	---	---
Zinc		N/A	N/A	N/A	N/A	N/A
01-124-M001	1.05×10^{-1}	---	---	---	---	---
01-158-M001	1.74	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-32
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Ammonia		5×10^{-1}	N/A	N/A	N/A	N/A	N/A
01-122-M021	8×10^{-1}	X	---	---	---	---	---
01-122-M121	7×10^{-1}	X	---	---	---	---	---
01-123-M021	1.0	X	---	---	---	---	---
01-125-M021	6×10^{-1}	X	---	---	---	---	---
01-156-M021	4.6	X	---	---	---	---	---
01-158-M021	1.7	X	---	---	---	---	---
01-160-M021	1.2×10^{1}	X	---	---	---	---	---
01-162-M021	7×10^{-1}	X	---	---	---	---	---
01-257-M021	5×10^{-1}	X	---	---	---	---	---
01-259-M021	7×10^{-1}	X	---	---	---	---	---
01-261-M021	1.4	X	---	---	---	---	---
01-263-M021	7×10^{-1}	X	---	---	---	---	---
TDS		2×10^{2}	N/A	N/A	N/A	N/A	
01-122-M001	1.8×10^{3}	X	---	---	---	---	---
01-122-M101	1.8×10^{3}	X	---	---	---	---	---
01-123-M001	9.9×10^{2}	X	---	---	---	---	---
01-124-M001	5.9×10^{2}	X	---	---	---	---	---
01-125-M001	8.8×10^{2}	X	---	---	---	---	---
01-156-M001	1.4×10^{3}	X	---	---	---	---	---
01-158-M001	2.6×10^{3}	X	---	---	---	---	---
01-160-M001	5.6×10^{2}	X	---	---	---	---	---
01-162-M001	1.8×10^{3}	X	---	---	---	---	---
01-257-M001	2.0×10^{3}	X	---	---	---	---	---
01-259-M001	1.3×10^{3}	X	---	---	---	---	---
01-261-M001	2.2×10^{3}	X	---	---	---	---	---
01-263-M001	1.4×10^{3}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-32
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
<u>Ammonia</u>		N/A	N/A	N/A	N/A	N/A
01-122-M021	8×10^{-1}	---	---	---	---	---
01-122-M121	7×10^{-1}	---	---	---	---	---
01-123-M021	1.0	---	---	---	---	---
01-125-M021	6×10^{-1}	---	---	---	---	---
01-156-M021	4.6	---	---	---	---	---
01-158-M021	1.7	---	---	---	---	---
01-160-M021	1.2×10^{1}	---	---	---	---	---
01-162-M021	7×10^{-1}	---	---	---	---	---
01-257-M021	5×10^{-1}	---	---	---	---	---
01-259-M021	7×10^{-1}	---	---	---	---	---
01-261-M021	1.4	---	---	---	---	---
01-263-M021	7×10^{-1}	---	---	---	---	---
<u>TDS</u>		N/A	N/A	N/A	N/A	N/A
01-122-M001	1.8×10^{3}	---	---	---	---	---
01-122-M101	1.8×10^{3}	---	---	---	---	---
01-123-M001	9.9×10^{2}	---	---	---	---	---
01-124-M001	5.9×10^{2}	---	---	---	---	---
01-125-M001	8.8×10^{2}	---	---	---	---	---
01-156-M001	1.4×10^{3}	---	---	---	---	---
01-158-M001	2.6×10^{3}	---	---	---	---	---
01-160-M001	5.6×10^{2}	---	---	---	---	---
01-162-M001	1.8×10^{3}	---	---	---	---	---
01-257-M001	2.0×10^{3}	---	---	---	---	---
01-259-M001	1.3×10^{3}	---	---	---	---	---
01-261-M001	2.2×10^{3}	---	---	---	---	---
01-263-M001	1.4×10^{3}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-33

Analyte Concentrations in SWLF Surface Water Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Butyl benzyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
01-504-W001	$<6 \times 10^{-3}$	X	---	---	---	---	---
Diethyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
01-501-W002	$<6 \times 10^{-3}$	X	---	---	---	---	---
Di-n-butyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
01-501-W002	$<1 \times 10^{-3}$	X	---	---	---	---	---
01-502-W002	$<1 \times 10^{-3}$	X	---	---	---	---	---
01-503-W102	$<2 \times 10^{-3}$	X	---	---	---	---	---
4-Nitrophenol		1×10^{-3}	N/A	N/A	N/A	N/A	N/A
01-501-W002	$<1.2 \times 10^{-2}$	X	---	---	---	---	---
Pentachlorophenol		1×10^{-3}	N/A	N/A	N/A	N/A	N/A
01-501-W002	$<7 \times 10^{-3}$	X	---	---	---	---	---
Phenol		1×10^{-3}	N/A	N/A	N/A	N/A	N/A
01-501-W002	$<9 \times 10^{-3}$	X	---	---	---	---	---
Arsenic		N/A	N/A	N/A	N/A	N/A	2.2×10^{-5}
01-501-W001	3.2×10^{-2}	---	---	---	---	---	X
01-503-W002	5×10^{-3}	---	---	---	---	---	X
01-503-W102	6×10^{-3}	---	---	---	---	---	X
Cadmium		2×10^{-4}	N/A	1×10^{-2}	3.9×10^{-3}	1.1×10^{-3}	1×10^{-2}
01-501-W001	6.6×10^{-2}	X	---	X	X	X	X
01-501-W002	5×10^{-3}	X	---	---	X	X	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-33
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Butyl benzl phthalate		N/A	N/A	N/A	N/A	N/A
01-504-W001	<6×10^{-3}	---	---	---	---	---
Diethylphthalate		N/A	N/A	N/A	N/A	N/A
01-501-W002	<6×10^{-3}	---	---	---	---	---
Di-n-butyl phthalate		N/A	N/A	N/A	N/A	N/A
01-501-W002	<1×10^{-3}	---	---	---	---	---
01-502-W002	<1×10^{-3}	---	---	---	---	---
01-503-W102	<2×10^{-3}	---	---	---	---	---
4-Nitrophenol		N/A	N/A	N/A	N/A	N/A
01-501-W002	<1.2×10^{-2}	---	---	---	---	---
Pentachlorophenol		N/A	N/A	N/A	N/A	N/A
01-501-W002	<7×10^{-3}	---	---	---	---	---
Phenol		N/A	N/A	N/A	N/A	N/A
01-501-W002	<9×10^{-3}	---	---	---	---	---
Arsenic		2.5×10^{-5}	N/A	N/A	3×10^{-2}	N/A
01-501-W001	3.2×10^{-2}	X	---	---	X	---
01-503-W002	5×10^{-3}	X	---	---	X	---
01-503-W102	6×10^{-3}	X	---	---	X	---
Cadmium		1.2×10^{-2}	1×10^{-2}	N/A	5×10^{-3}	5×10^{-3}
01-501-W001	6.6×10^{-2}	X	X	---	X	X
01-501-W002	5×10^{-3}	---	---	---	---	---

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N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-33
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Copper		5×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
01-501-W001	3.2×10^{-2}	X	---	---	X	X	---
01-503-W001	3×10^{-2}	X	---	---	X	X	---
Iron		3×10^{-1}	N/A	N/A	N/A	N/A	N/A
01-501-W001	4.49×10^{1}	X	---	---	---	---	---
01-502-W001	1.29	X	---	---	---	---	---
01-503-W001	7.08×10^{-1}	X	---	---	---	---	---
01-503-W101	4.45×10^{-1}	X	---	---	---	---	---
01-504-W001	4.25×10^{-1}	X	---	---	---	---	---
01-501-W002	2.12×10^{1}	X	---	---	---	---	---
01-502-W002	3.24	X	---	---	---	---	---
01-503-W002	1.01	X	---	---	---	---	---
01-503-W102	1.13	X	---	---	---	---	---
01-504-W002	5.05×10^{-1}	X	---	---	---	---	---
Zinc		3×10^{-2}	N/A	N/A	N/A	N/A	N/A
01-501-W001	4.4×10^{-1}	X	---	---	---	---	---
01-501-W002	2.42×10^{-1}	X	---	---	---	---	---
01-502-W002	1.48×10^{-1}	X	---	---	---	---	---
01-503-W002	7×10^{-2}	X	---	---	---	---	---
TDS		200	N/A	N/A	N/A	N/A	N/A
01-502-W001	5.46×10^{2}	X	---	---	---	---	---
01-503-W101	3.26×10^{2}	X	---	---	---	---	---
01-504-W001	3.1×10^{2}	X	---	---	---	---	---
01-505-W001	2.7×10^{2}	X	---	---	---	---	---
01-501-W002	1.4×10^{3}	X	---	---	---	---	---
01-502-W002	9.9×10^{2}	X	---	---	---	---	---
01-503-W002	3.8×10^{2}	X	---	---	---	---	---
01-503-W102	3.4×10^{2}	X	---	---	---	---	---
01-504-W002	6.0×10^{2}	X	---	---	---	---	---
01-505-W002	3.8×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
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N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-33
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Copper		N/A	N/A	N/A	N/A	N/A
01-501-W001	3.2×10^{-2}	---	---	---	---	---
01-503-W001	3×10^{-2}	---	---	---	---	---
Iron		N/A	N/A	N/A	N/A	N/A
01-501-W001	4.49×10^{1}	---	---	---	---	---
01-502-W001	1.29	---	---	---	---	---
01-503-W001	7.08×10^{-1}	---	---	---	---	---
01-503-W101	4.45×10^{-1}	---	---	---	---	---
01-504-W001	4.25×10^{-1}	---	---	---	---	---
01-501-W002	2.12×10^{1}	---	---	---	---	---
01-502-W002	3.24	---	---	---	---	---
01-503-W002	1.01	---	---	---	---	---
01-503-W102	1.13	---	---	---	---	---
01-504-W002	5.05×10^{-1}	---	---	---	---	---
Zinc		N/A	N/A	N/A	N/A	N/A
01-501-W002	4.4×10^{-1}	---	---	---	---	---
01-501-W002	2.42×10^{-1}	---	---	---	---	---
01-502-W002	1.48×10^{-1}	---	---	---	---	---
01-503-W002	7×10^{-2}	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
01-502-W001	5.46×10^{2}	---	---	---	---	---
01-503-W101	3.26×10^{2}	---	---	---	---	---
01-504-W001	3.1×10^{2}	---	---	---	---	---
01-505-W001	2.7×10^{2}	---	---	---	---	---
01-501-W002	1.4×10^{3}	---	---	---	---	---
01-502-W002	9.9×10^{2}	---	---	---	---	---
01-503-W002	3.8×10^{2}	---	---	---	---	---
01-503-W102	3.4×10^{2}	---	---	---	---	---
01-504-W002	6.0×10^{2}	---	---	---	---	---
01-505-W002	3.8×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-34

Contaminants of Concern at SWLF, IRP Stage 2, Selfridge ANGB, MI

	Maximum Concentration Detected in Medium		
	Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
Ammonia[a]		12	0.4
Benzene[b]		0.06	
Nickel[d]	0.382	0.087	0.053
Cadmium[d]	0.0018	0.047	0.066
4-Methyl-2-pentanone[a]	0.00066		
Dichlorodifluoromethane[a]		0.45	
Methylene chloride[a]		0.31	
Chlorinated benzenes			
1,3-Dichlorobenzene		0.093	
1,4-Dichlorobenzene		0.018	
2-Butanone	0.00034		
Acetone[a]	0.00044		
Phenolics			
2,4-Dimethylphenol		0.08	
Pentachlorophenol[b]			0.007
4-Nitrophenol[a]			0.012
Phenol	0.24		0.009
Pentachlorophenol			0.007
1,1-Dichloroethane[a]		0.012	
1,2-Dichloroethane[b]		0.0051[c]	
Trichloroethene[b]		0.17[c]	

[a]No Federal or state criteria exist at present for contaminant levels in groundwater or surface water.
[b]Known/suspected carcinogen (oral route).
[c]Exceeds EPA drinking water Maximum Contaminant Level.
[d]Known/suspected carcinogen (inhalation route).
[e]Exceeds EPA ambient water quality criteria for the protection of human health.
[f]Exceeds EPA proposed Maximum Contaminant Level Goal.

Table 4-34
(continued)

	Maximum Concentration Detected in Medium		
	Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
1,1,2,2-Tetrachloroethane[b]		0.0073[e]	
Trichlorofluoromethane[a]			0.15
Tetrachloroethene[b]		0.0039[e]	
1,2-Dichloroethene (total)	0.0001		
trans-1,2-Dichloroethene		0.65[f]	
Vinyl chloride[b]		0.068[c]	
<u>Phthalates</u>			
Diethyl phthalate		0.16	0.006
Di-n-butyl phthalate	0.00003	0.01	0.002
Butyl benzyl phthalate		0.002	0.006
Bis(2-ethylhexyl) phthalate	0.00012	0.026	
<u>PAHs</u>			
Anthracene	0.00005		
Chrysene	0.000011		
Benzo(k)fluoranthene[b]	0.00008		
Pyrene	0.00015		
Benzo(b)fluoranthene	0.00015		
Fluoranthene	0.0002		
Indeno(1,2,3-c,d)pyrene[b]	0.00012		
Phenanthrene	0.00018		
Benzo(a)pyrene[b]	0.00012		
Benzo(a)anthracene	0.00011		
Benzo(g,h,i)perylene	0.00011		

[a]No Federal or state criteria exist at present for contaminant levels in groundwater or surface water.
[b]Known/suspected carcinogen (oral route).
[c]Exceeds EPA drinking water Maximum Contaminant Level.
[d]Known/suspected carcinogen (inhalation route).
[e]Exceeds EPA ambient water quality criteria for the protection of human health.
[f]Exceeds EPA proposed Maximum Contaminant Level goal.

Surface water samples at SWLF were taken from two surface impoundments. Contaminants found in these waters include metals, phenolics, phthalates, halogenated olefins, and halomethanes. These contaminants are probably present due to runoff from contaminated surface soils. Some of the contaminants present in the surface water were found at levels that exceed Federal or state recommendations or standards, where such standards exist.

According to base records there are no active wells on the base. Therefore, direct contact with groundwater via use of well water is not considered a potential exposure pathway on the base as a whole. This is also true for those areas outside the base because no groundwater use occurs within 1 mile of the site.

The area around SWLF is drained primarily by the stormwater drainage system. This system receives precipitation runoff through storm sewer inlets and from local surface drainageways. Because SWLF contains surface soil contamination runoff could carry contaminants into the stormwater drainage system by this route. Additionally, the stormwater drainage system is believed to receive groundwater seepage from the site. Movement of groundwater into the stormwater drainage system on the base as a whole is believed to far exceed direct groundwater discharge into the Clinton River or Lake St. Clair. However, the river and lake ultimately receive all groundwater via discharge by the stormwater drainage system or natural groundwater discharge.

Several compounds, mostly halogenated olefins, are present in groundwater at SWLF at concentrations in excess of EPA-established ambient water quality criteria and drinking water standards. A worst-case exposure scenario for contaminated groundwater would be at the discharge point from the stormwater drainage system into the Clinton River. Concentrations of contaminants could be present in this discharge at levels exceeding those established by EPA to be safe for the general population. Dilution of this contaminated groundwater between the time it enters the stormwater drainage system at the site and its discharge point is unknown. Additionally, water discharged into the Clinton River would be rapidly diluted by the large surface water volume. Therefore, actual concentrations of contaminants in water contacted by receptors may be less. Potential receptors for this diluted discharge include recreational surface water users and aquatic and terrestrial biota.

Currently, no Federal or State of Michigan guidelines exist which define cleanup levels for contaminants in soil. However, the EPA has developed a list of proposed media protection standards for suspected carcinogens which represent concentrations of contaminants in air, groundwater, and soil that will result in an excess cancer risk of 10^{-6}. Several contaminants, including halomethanes, halogenated olefins, phthalates, and

metals in excess of background levels, were found in site soils. However, none of the contaminants found in site soils have corresponding proposed media protection standards.

Although it is known that surface soils at SWLF contain volatile contaminants, the extent of ambient airborne contamination from this route is not known. Rapid dilution of airborne contaminants before contact with human receptors would be expected at this site.

At the present time, direct contact of base personnel with contaminants at this site is unlikely unless they are involved in work at the site. Contact with contaminated groundwater at the point of stormwater discharge is possible and could involve an exposure to contaminants in water at concentrations in excess of Federal criteria. However, rapid dilution of this outflow would be likely. If remedial activities are conducted at SWLF or if it becomes necessary for base personnel to work at this site, quantification of exposure via dermal contact and inhalation will be necessary. Ambient air monitoring data would also be required in this case.

4.5 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- FIRE TRAINING AREA 2

4.5.1 Pathway Characterization and Migration Potential -- FTA-2

4.5.1.1 Subsurface Conditions -- FTA-2

Natural soils around the FTA-2 site are mapped by the USDA Soil Survey (see Figure 2-5) as belonging to the Lamson Series. Soils of this series have developed from the sandy silt and sand alluvial deposits present at the surface in this part of the base. Lamson Series soils are generally found outside the area cleared for fire training exercises. The active fire training pit and the area immediately surrounding it consist of mechanically reworked natural soil and fill materials added during the construction of the FTA-2 burn pit.

Three soil borings (02-422, 02-423, and 02-424) were drilled at FTA-2 within the bermed burn pit area to a depth of 30 feet. Between 0 and 5 feet these borings encountered green-gray silt and sandy clay with brown mottling. The top 1 to 2 feet of this interval consisted of fill material. Below 5 feet borings predominantly showed gray clay to silty clay.

The top of the saturated zone was encountered between 10 and 11 feet in the soil borings during drilling. Soil boreholes 02-423 and 02-424 were grouted the day following drilling, and it was noted that the water levels in these boreholes rose from 1.2 to 4.0 feet above the top of the saturated soils. The rising water levels indicate that a semi-confining pressure condition exists in the saturated soils underlying the site.

The background OVA reading at FTA-2 during drilling of soil borings was 1 unit. The soil core yielding the highest OVA reading in each of the three FTA-2 soil borings was the 0- to 5-foot interval. In soil borings 02-422, 02-423, and 02-424, soil samples from 0 to 5 feet registered OVA measurements of 100 to 500 units, 100 to 700 units, and 10 to 40 units, respectively.

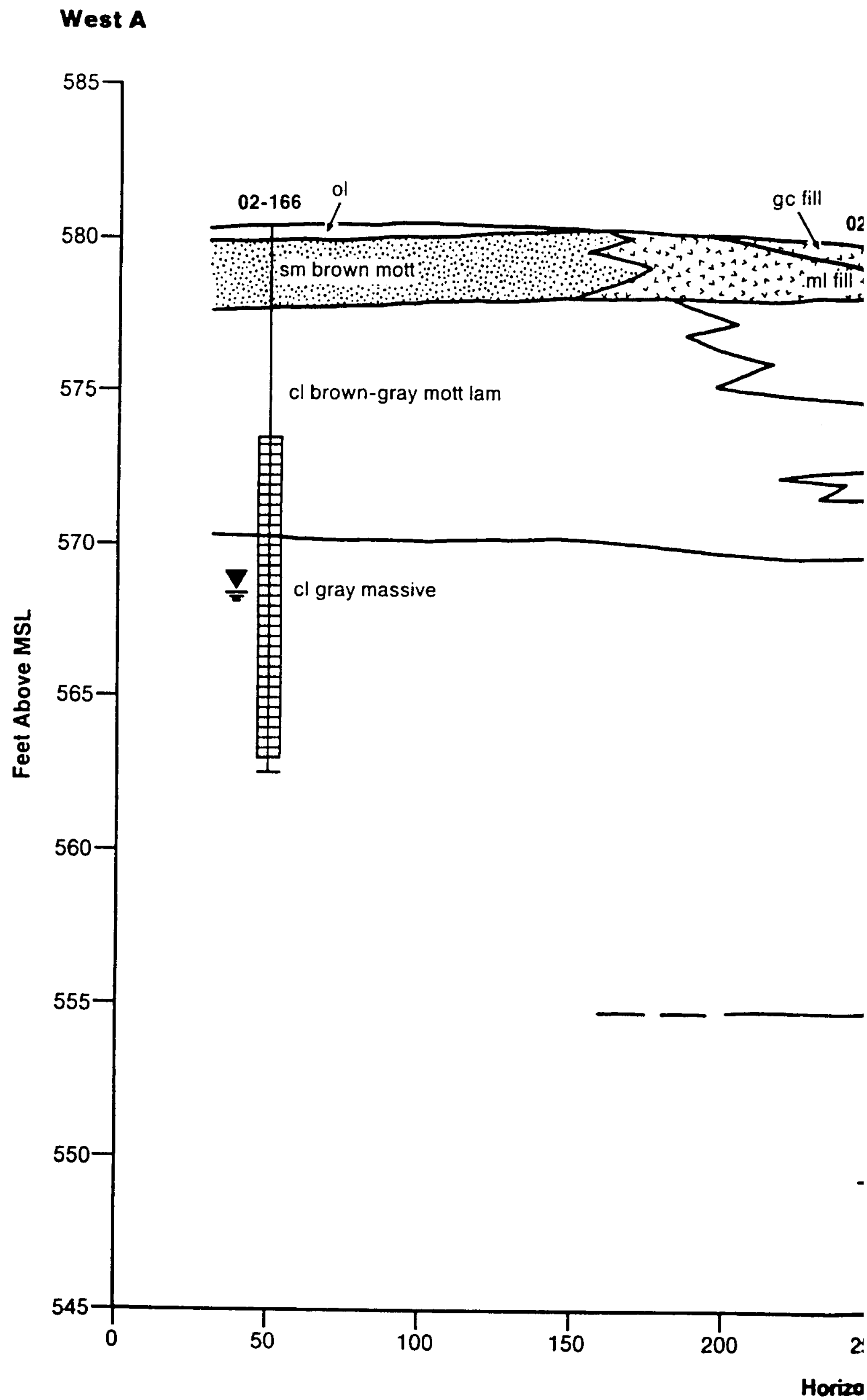
A petroleum odor was detected emanating from soil boreholes 02-422 and 02-423 during drilling, primarily in the top 10-foot interval. A foamy appearance was also noted on the surface of water present in these boreholes prior to grouting. A petroleum odor was also detected. Level C personnel protection was used at soil borings 02-422 and 02-423 and between 0 to 10 feet at 02-424. Protection was downgraded to Level D, based upon OVA monitoring of the breathing zone between 10 and 30 feet in soil boring 02-424.

Three monitor wells installed at FTA-2 during the previous IRP study had been damaged or destroyed. Three new monitor wells (02-164, 02-165, and 02-166) were installed to replace the previous monitor wells and to provide continued groundwater monitoring at the site. The replacement monitor wells were relocated in more-protected areas outside the active area of FTA-2. Monitor well 02-166 was placed in an upgradient location, and the other two monitor wells were installed in downgradient positions, based upon the potentiometric map of the IRP Phase II Stage 1 study.

Monitor well 02-164 was relocated to a position northeast of FTA-2 so that it would also be downgradient of a surface pond containing a mixture of excess JP-4 and firefighting water from the burn pit. This mixture of JP-4 and water from firefighting exercises is collected by a drain inside the burn pit and then discharged into a series of natural depressions located in the tree-covered area 150 feet northeast of FTA-2. Monitor well 02-165 was installed to the southeast of the burn pit, along the perimeter of the cleared area at FTA-2.

Figure 4-34 shows the cross section through FTA-2, which presents the relationship and character of the geology at the site. The trace of the cross section is shown in Figure 4-35. Fill material was encountered in monitor well borings 02-164 and 02-165 between 0 to 2.5 feet. A silt to silty clay of lacustrine origin occurred from 2.5 feet to the bottom of each well borehole. The same sequence of material was found at monitor well borehole 02-166 from 2.4 to 17.5 feet. The upper 2.4 feet of the borehole was comprised of a thin silt topsoil horizon and a silty sand.

OVA readings did not exceed background level in soil samples taken from the upper 10 feet of the replacement monitor well boreholes at FTA-2. Below 10 feet readings were generally below



West A
Feet Above MSL
585
580
575
570
565
560
555
550
545
0
50
100
150
200
02-166
ol
gc fill
sm brown mott
ml fill
cl brown-gray mott lam
cl gray massive
Horizo

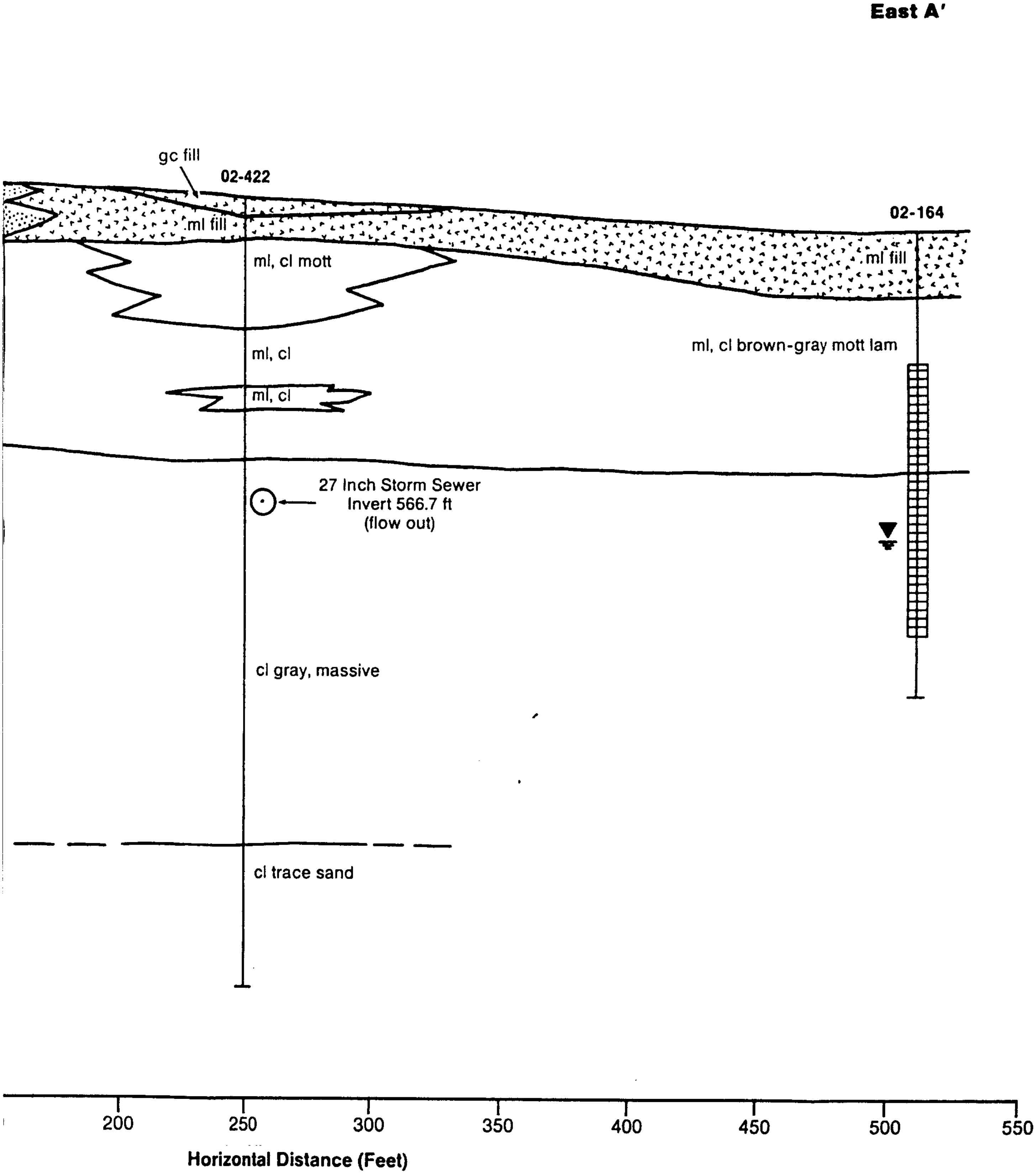


FIGURE 4-34 FT.
CR

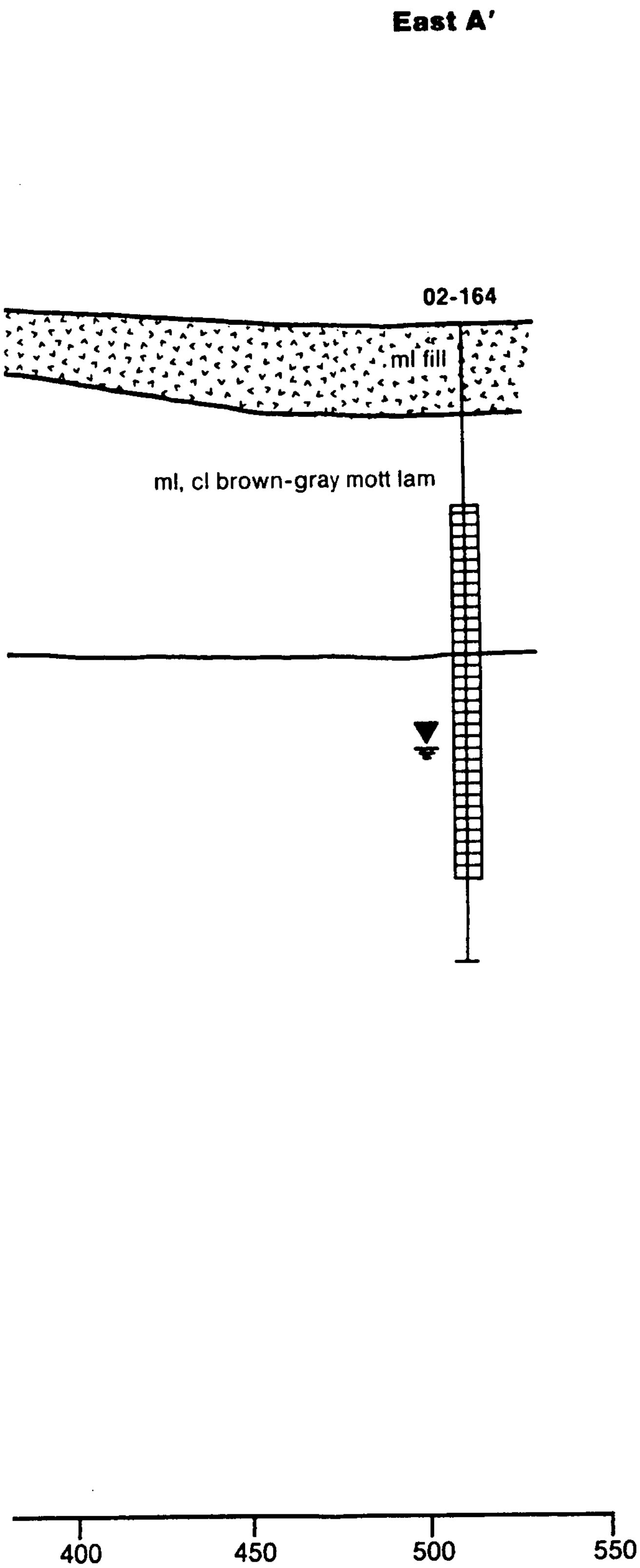
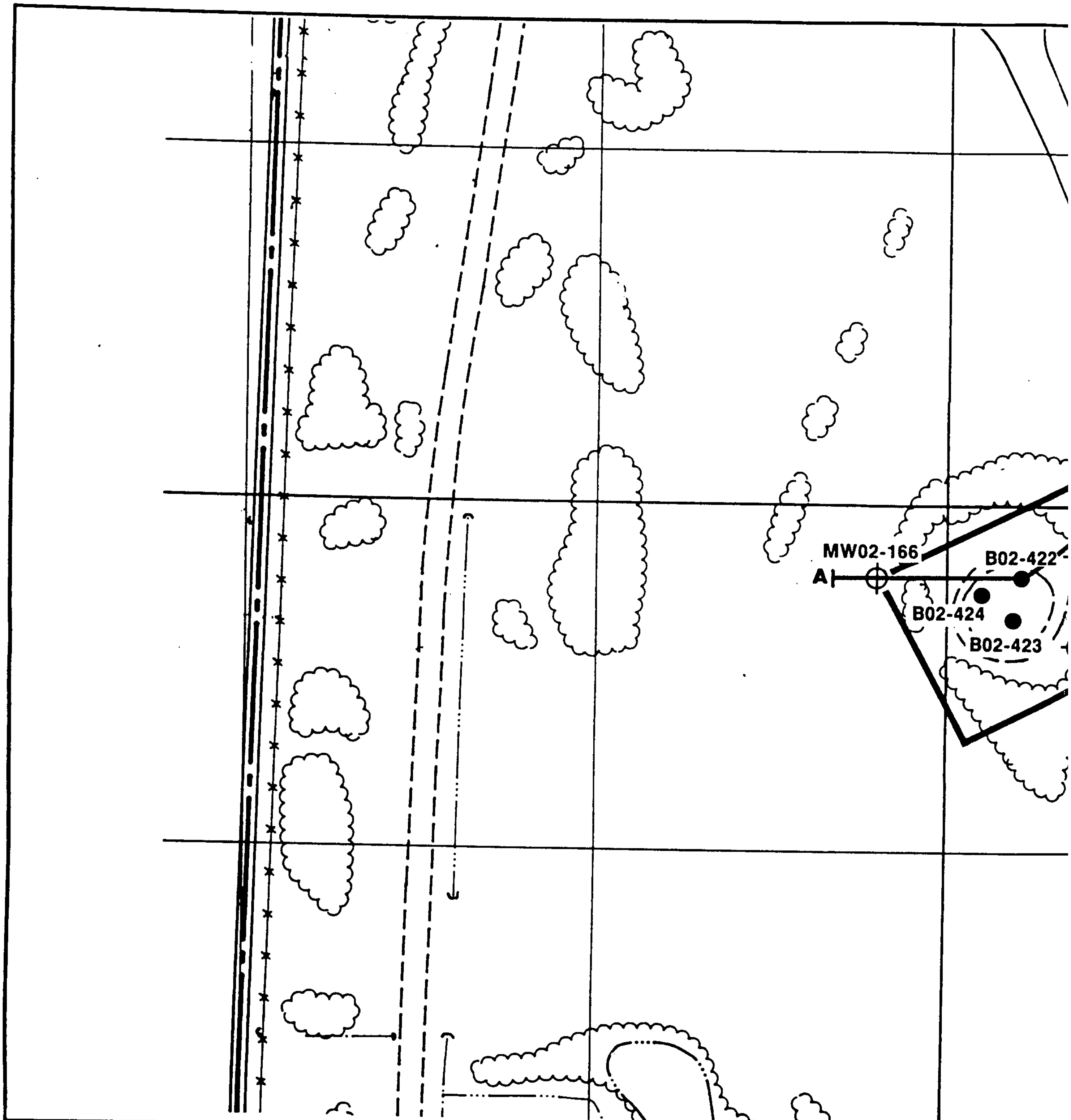


FIGURE 4-34 FTA-2 GEOLOGIC CROSS SECTION A-A'



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

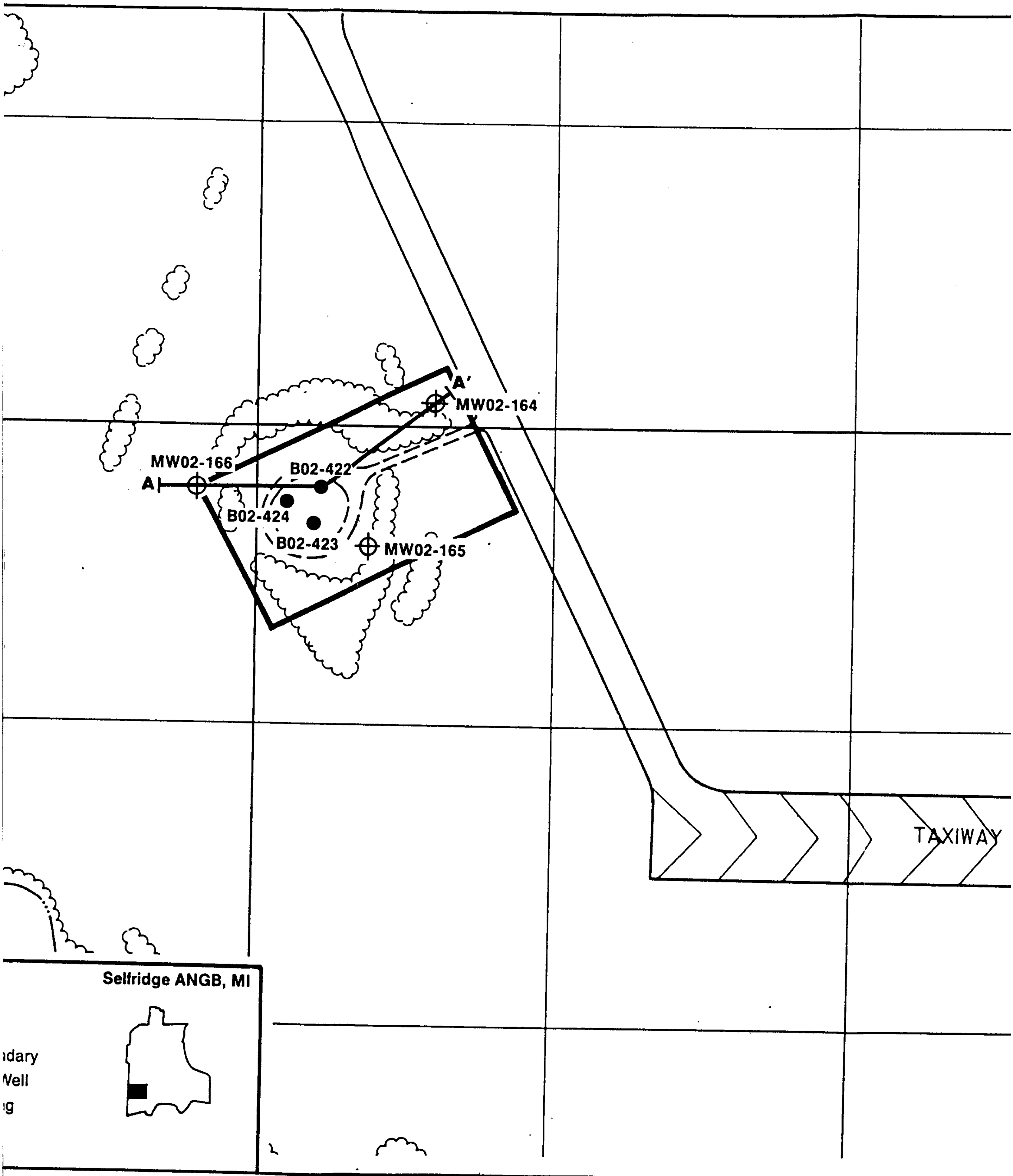
Site Boundary

MW02-166 Shallow Well

B02-422 Soil Boring

0 100 200 400

Scale in Feet



A
A'
MW02-164
MW02-166
B02-422
B02-424
B02-423
MW02-165
TAXIWAY
Selfridge ANGB, MI
ıdary
Well
ıg

:UR

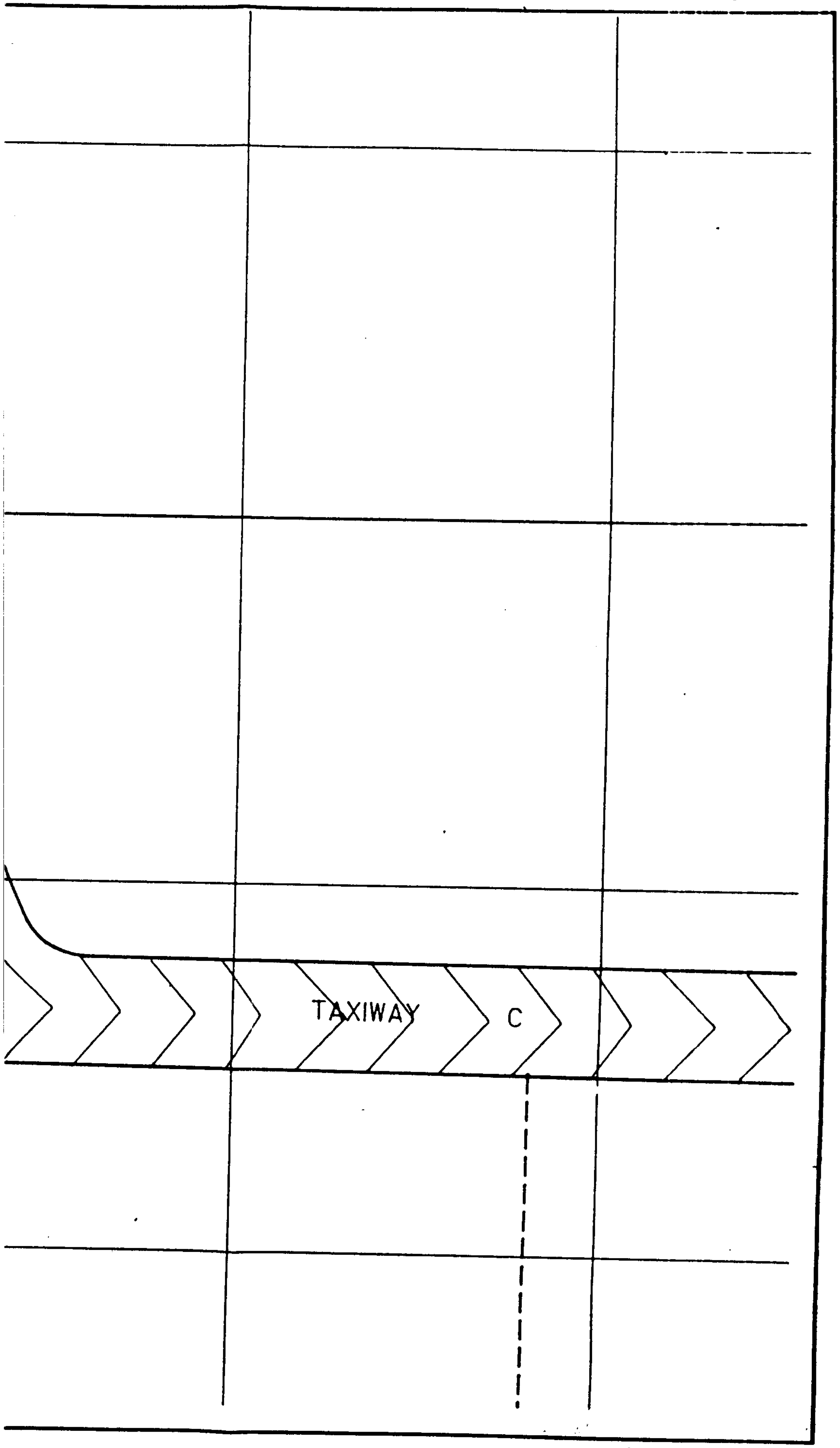


FIGURE 4-35 TRACE OF CROSS SECTION A-A' AT FTA-2

10 units. The maximum reading obtained from the soil samples taken from the well boreholes was 10 to 40 units in the 15- to 18-foot sample interval for monitor well 02-164. No visible signs of potential subsurface contamination were observed during drilling of the FTA-2 replacement monitor wells, nor were any unusual odors noted.

Passing directly underneath the FTA-2 site is a 27-inch diameter stormwater drainage pipe that carries stormwater runoff collected from the base airfield area east of the site. The top of the pipe is located approximately 11 feet BLS. The pipe is buried in a gray, massive, silty clay.

4.5.1.2 Extent and Character of Unsaturated Zone -- FTA-2

Fill material was encountered in the upper 3 to 5 feet of the burn pit area. Where the soil borings were drilled, the fill material was comprised of a mixture of silt, clay, and sand. During the installation of monitor wells 02-164 and 02-165 fill material was encountered between 0 and 2.5 feet BLS. The fill material consisted of clayey silt and sand at monitor well 02-164. Fill material at monitor well 02-165 was comprised of silt, gravel, and pieces of asphalt.

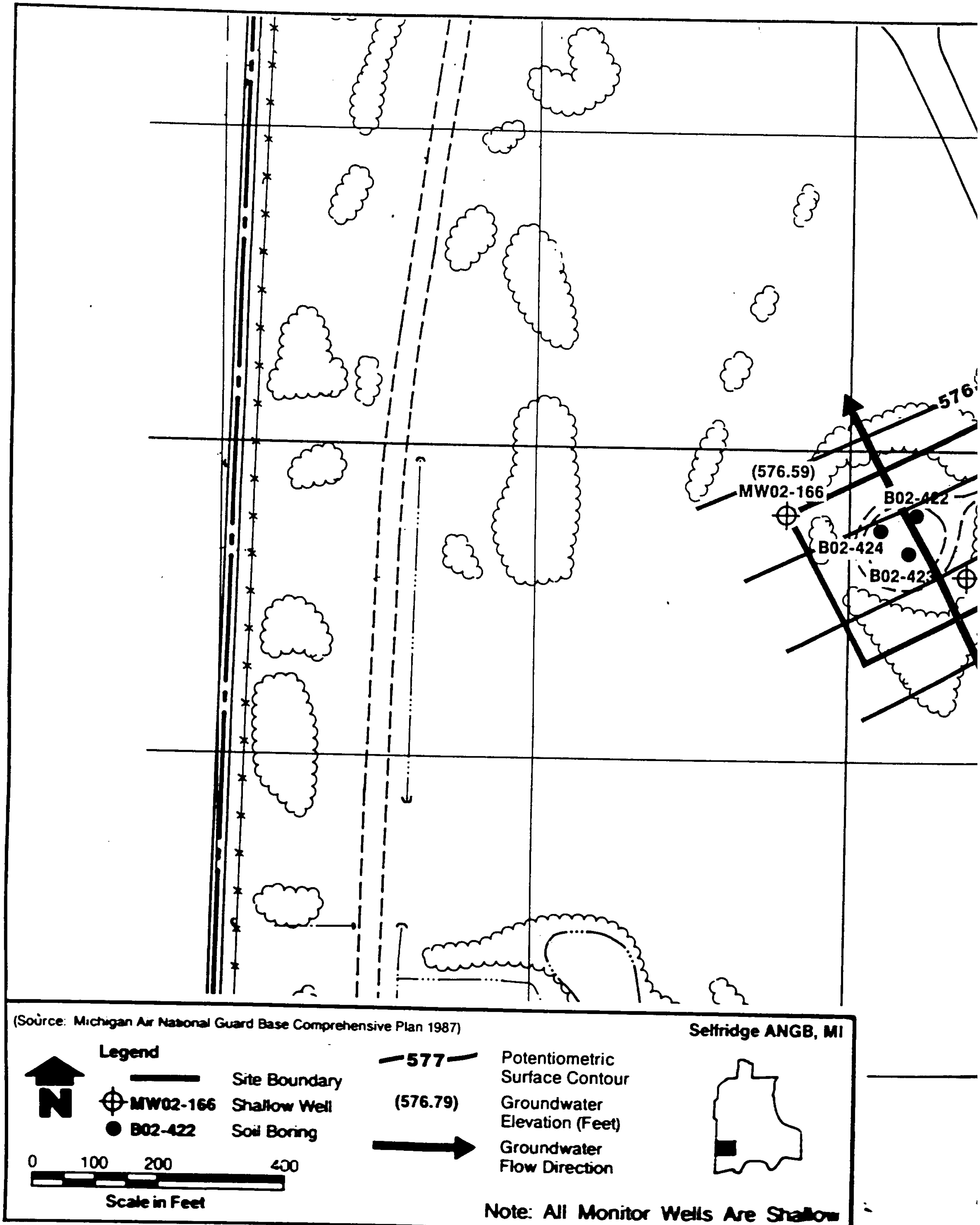
As observed in the soil samples collected from soil and monitor well borings, the unsaturated zone occurs to a depth of between 10 and 11 feet BLS. The soils in the unsaturated zone were moist and of low to medium plasticity. Mottling of the soils appeared as an iron-stained discoloration. Varying shades of gray laminations were seen in this zone, as are commonly observed in lacustrine deposits.

4.5.1.3 Groundwater Conditions -- FTA-2

Saturated conditions as observed from soil and well borings occurred between 10 and 11 feet BLS. At this depth mottling of the silty clay and silt was dominantly gray. The lacustrine sediments were highly plastic and wet as determined from field observations.

Potentiometric surface maps were constructed based upon water levels in the three monitor wells. During the early part of the IRP study, based upon water level data for 21 March and 17 May 1988, groundwater flow was in a northerly direction. The potentiometric surface map for 21 March 1988 is shown in Figure 4-36. Based upon this map the groundwater gradient is 0.008 ft/ft.

Groundwater flow has a southeast trend for the periods 20 June and 1 August 1988. The potentiometric surface map for 1 August 1988 is shown in Figure 4-37. A gradient of 0.006 ft/ft was calculated based upon water level data for this period.


576
(576.59)
MW02-166
B02-422
B02-424
B02-423
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW02-166 Shallow Well
B02-422 Soil Boring
N
0 100 200 400
Scale in Feet
577 Potentiometric Surface Contour
(576.79) Groundwater Elevation (Feet)
Groundwater Flow Direction
Note: All Monitor Wells Are Shallow

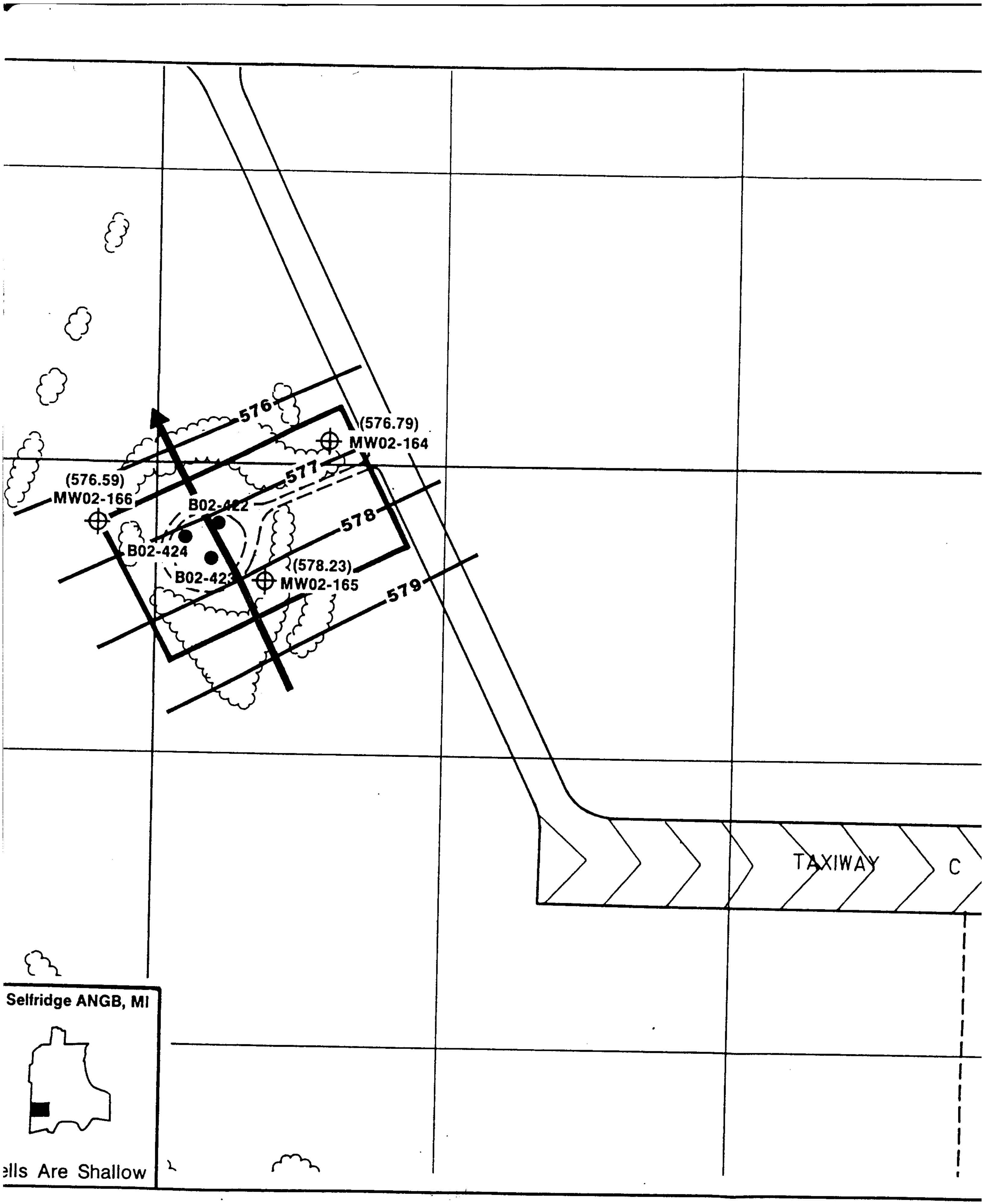


FIGURE 4-36 FTA-2 P
MAP ON

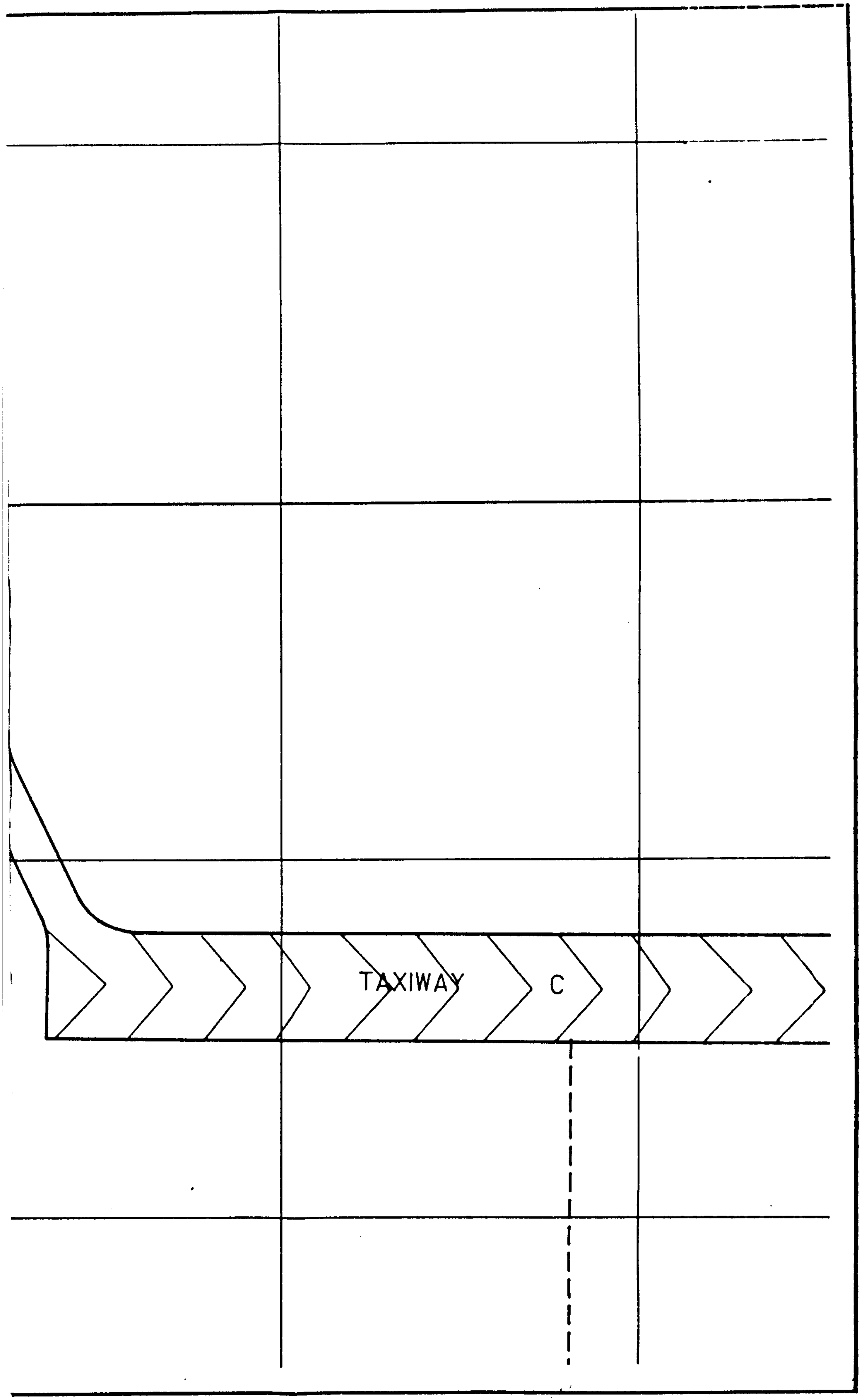
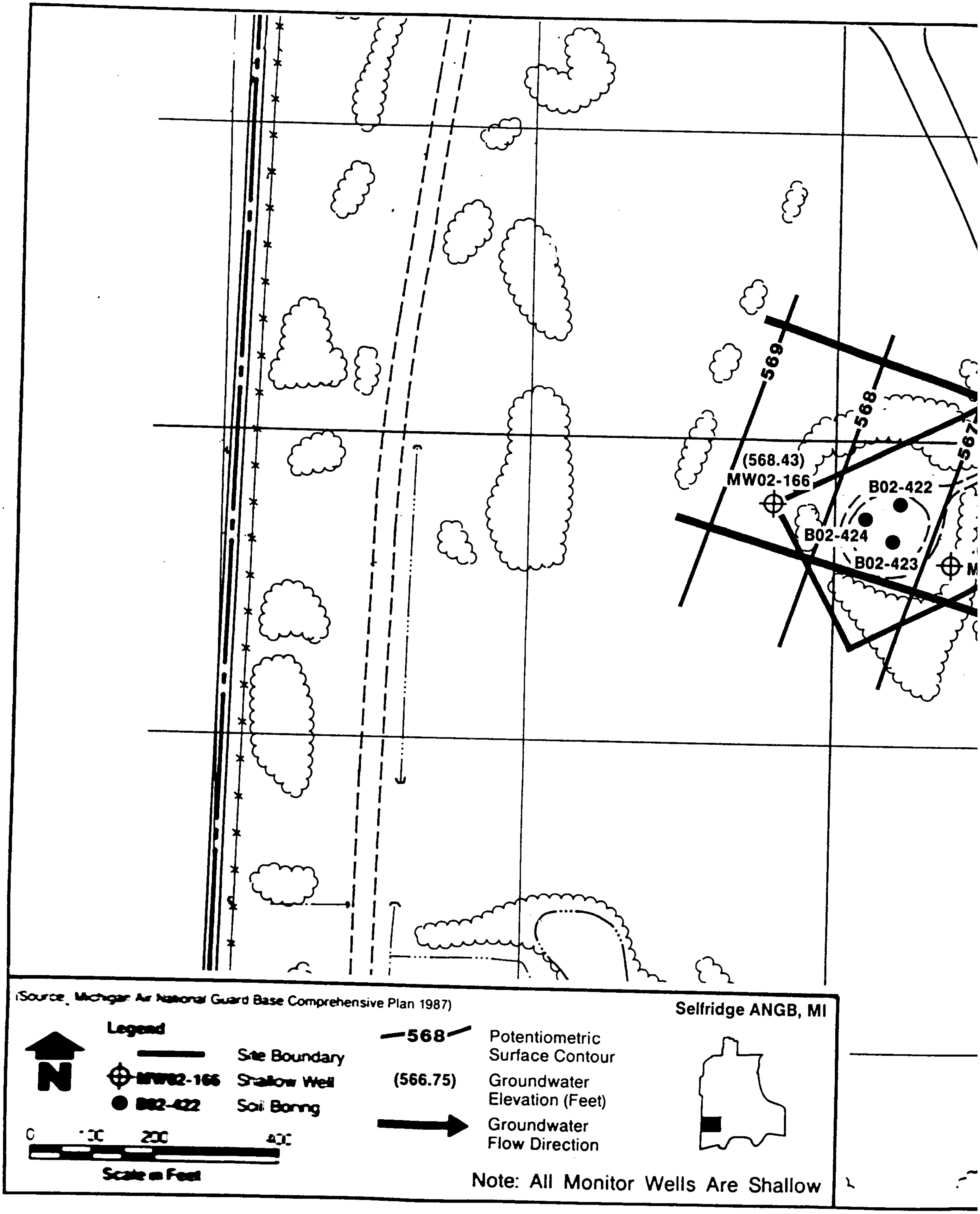


FIGURE 4-36 FTA-2 POTENTIOMETRIC SURFACE MAP ON 21 MARCH 1988


569
568
567
(568.43)
MW02-166
B02-422
B02-424
B02-423
(Source, Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW02-166 Shallow Well
B02-422 Soil Boring
568 Potentiometric Surface Contour
(566.75) Groundwater Elevation (Feet)
Groundwater Flow Direction
0
200
400
Scale in Feet
Note: All Monitor Wells Are Shallow

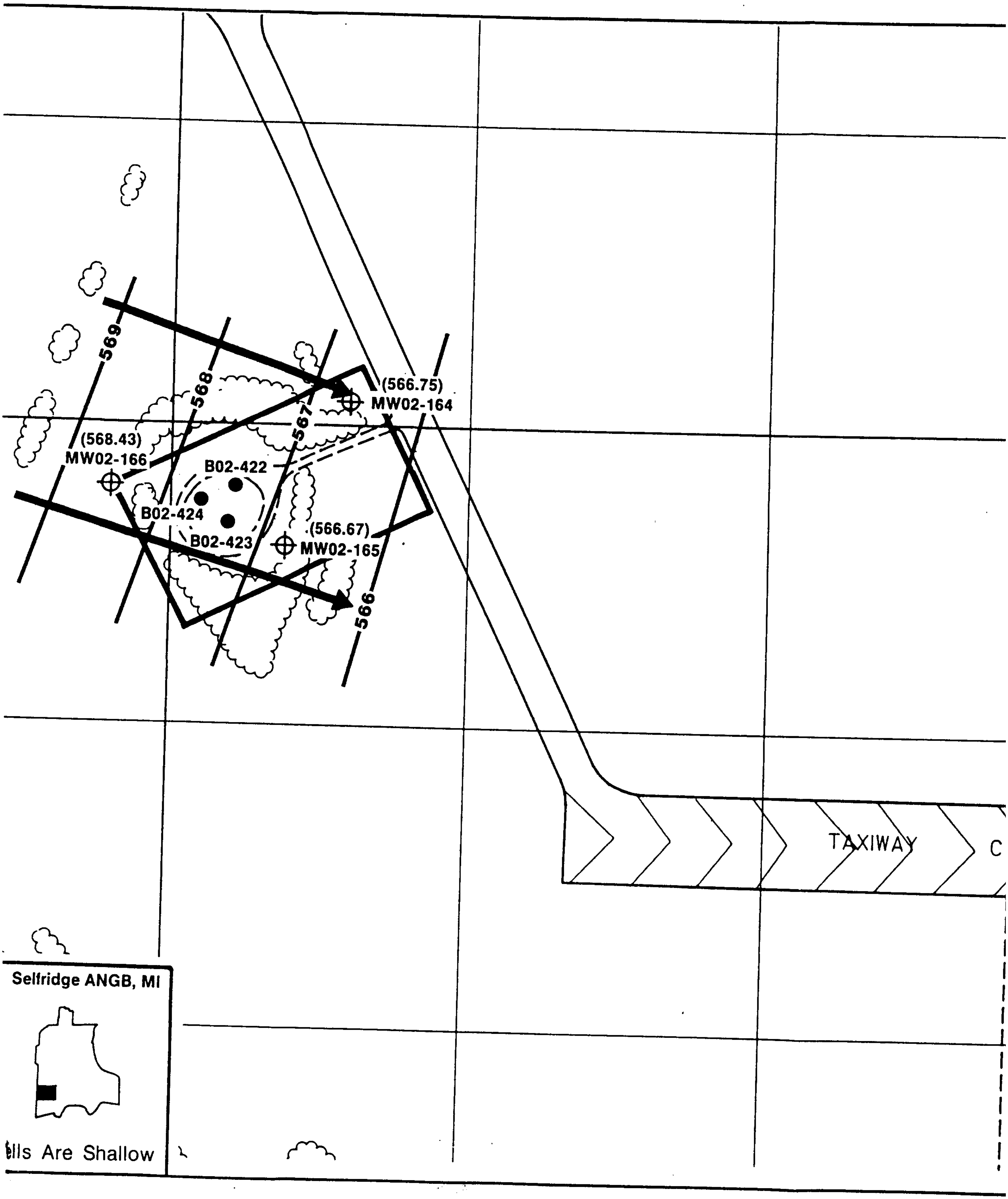


FIGURE 4-37 FTA-2
MAP C

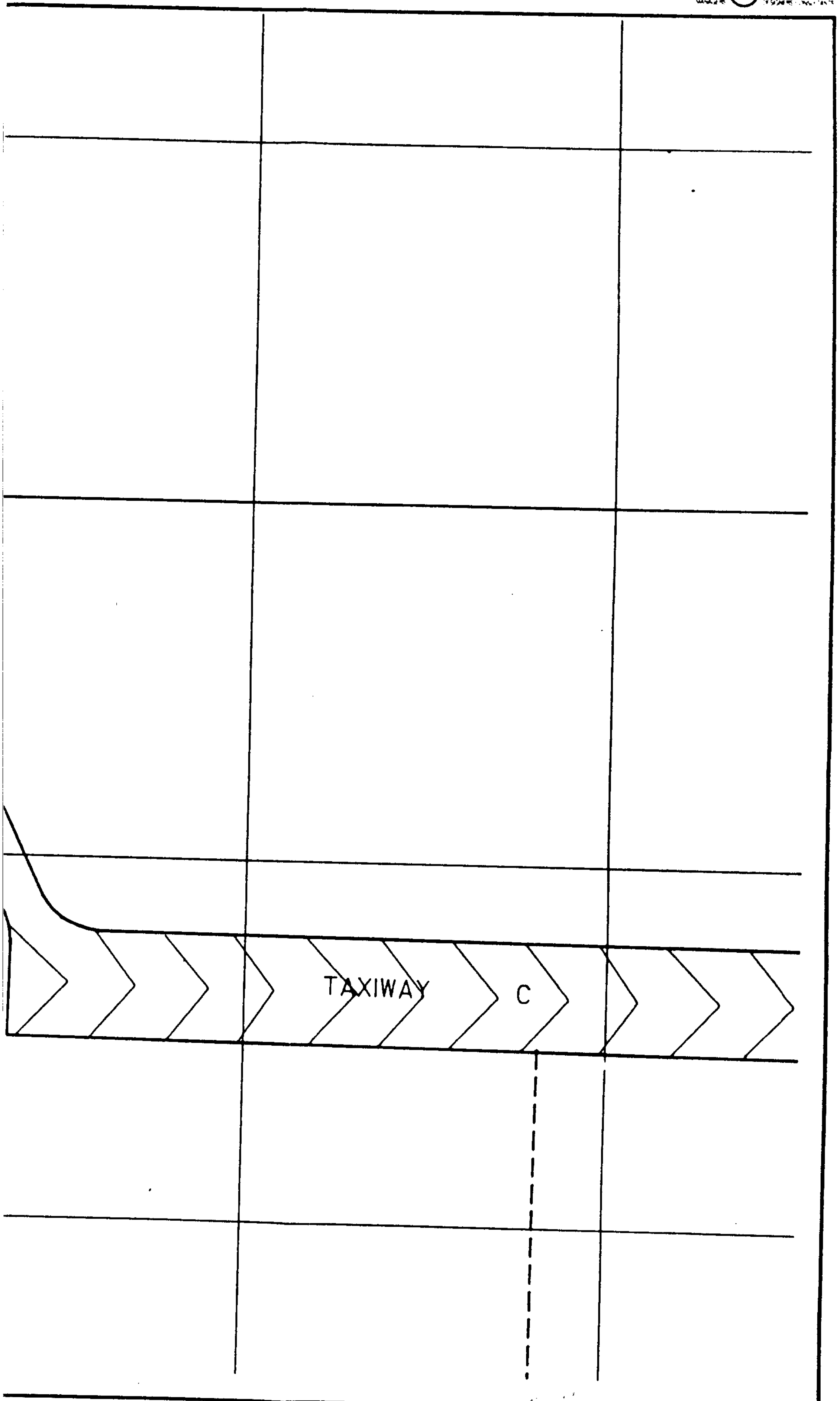


FIGURE 4-37 FTA-2 POTENTIOMETRIC SURFACE MAP ON 1 AUGUST 1988

Measured hydraulic conductivity (K) values at FTA-2 ranged from 1.95×10^{-6} ft/sec (5.94×10^{-4} cm/sec) to 5.03×10^{-7} ft/sec (1.53×10^{-5} cm/sec). The average hydraulic conductivity for the FTA-2 site is 1.07×10^{-6} ft/sec (3.26×10^{-5} cm/sec). Based upon the average hydraulic conductivity, the gradient, and the effective porosity, a groundwater velocity can be calculated (see Subsection 4.4.1.3). Silty clays and silts have a total porosity between 33 and 60 percent. An effective porosity of 15 percent was used to calculate the groundwater velocity. For the period 21 March 1988 the groundwater velocity was 5.70×10^{-8} ft/sec (1.80 ft/year). The groundwater velocity on 1 August 1988 was 4.27×10^{-8} ft/sec (1.35 ft/year).

On 17 May 1988 water levels in monitor wells at FTA-2 were higher than the surface elevation of Lake St. Clair (574.62 feet above MSL). The differences in elevations ranged from 0.42 feet at monitor well 02-164 to 2.15 feet at monitor well 02-165. These elevated water levels in the monitor wells, as compared to Lake St. Clair, were generally observed during the period 1 February to 17 May 1988. Water levels in the three monitor wells on 20 June and 1 August 1988 were lower than the surface water elevation of Lake St. Clair for the same period. On 1 August 1988 water levels in the monitor wells were 5.80 to 7.56 feet lower.

Part of this difference in water level may be due to slow recharge of the monitor wells following the initial round of groundwater sampling. However, most of the overall decline in water levels is believed to reflect a significant decrease in groundwater recharge to the base area due to near drought conditions during the summer of 1988. The basewide potentiometric map for shallow monitor wells (see Figure 4-13) suggests that the FTA-2 area is a localized groundwater sink -- an area of greater discharge to the stormwater system. The interaction of groundwater and the stormwater system and the seasonal change in recharge is probably the reason for changing or reversing groundwater flow directions. The net result of these interactions and effects appears to be that groundwater at FTA-2 does not migrate away from the site, but rather oscillates back and forth in place and/or discharges to the stormwater system.

4.5.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- FTA-2

The 1- to 2-foot high berm constructed around the burn pit at FTA-2 helps to contain waste fuel (JP-4) and firefighting water added to the site during fire training exercises. A drain inside the burn pit serves to divert excess firefighting water, waste fuel residue remaining after a fire training exercise, and surface water from precipitation events into the wooded area northeast of the site. Complete drainage of the pit is not, however, accomplished by the drain. Some waste fuel and water were observed ponding inside the pit.

Water and JP-4 drained from the burn pit accumulated in three small depressions in the wooded area northeast of the site. A dark staining of vegetation and the ground surface can be seen in this area. This contaminated water is not contained in this area other than by the generally low-lying topography of the area. Drainage of the water and fuel mixture to other areas outside the FTA-2 site is possible.

Another area where evidence of surface water contamination was observed was at surface water sampling location 02-506. This area, located south of monitor well 02-165, contained ponded surface water with an oily sheen visible on the surface. Vegetation in this area was also observed to have an oil film on its surface. Located approximately 50 feet south of these ponds of contaminated surface water was a shallow depression that served to collect surface water runoff. Contaminated water from the surface water ponds at sampling location 02-505 could possibly drain into this area after a precipitation event.

Catch basins connected to the stormwater drainage network are located on the eastern side of FTA-2, as shown in Figure 3-14. Potentially contaminated surface water could possibly be intercepted at these catch basins. Contaminants collected by these storm drains or infiltrating via groundwater would eventually be discharged into the Clinton River.

4.5.1.5 Direct Contact with Contaminated Media -- FTA-2

Firefighters and other personnel receiving fire training instruction at FTA-2 have the greatest potential for coming in direct contact with either contaminated water or soils. Direct contact with waste JP-4 burned at the site is also possible. According to the Records Search Report (ENCOTEC, 1983) approximately 12 fire training exercises are held each year. No information is available on the approximate number of base personnel or non-base personnel involved in these exercises.

4.5.1.6 Summary of Migration Pathways -- FTA-2

JP-4 residue was observed on surface soils and vegetation at the FTA-2 site. Direct contact with these contaminated soils by personnel working at the site is possible. Work activities conducted on the ground, such as fighting fires in the burn pit, could result in contact with contaminants.

Groundwater contaminated with JP-4 could migrate from the site, based upon the data from potentiometric surface maps; however, the stormwater drainage pipe under FTA-2 may be intercepting the groundwater. Intercepted groundwater would eventually be discharged by the stormwater drainage system into the Clinton River.

The surface water pathway provides a means for contaminants to be spread from the site to other areas. This includes ponding of surface water in the area immediately around FTA-2 as well as interception of surface water at catch basins and its eventual discharge to the Clinton River. Ponding of contaminated surface water in and around the site does occur. Ground maintenance crews and firefighters could come in direct contact with this water.

Volatization of waste JP-4 into the atmosphere is another pathway for contact with contaminants. Firefighters and base ground maintenance personnel working at either FTA-2 or the airfield area east of the site would be exposed by this pathway.

Wildlife are also exposed by the same contaminant pathways as discussed previously. Possible use of contaminated surface water bodies as either drinking water sources or aquatic habitat by wildlife provides a pathway for direct contact with contaminants.

4.5.2 Contamination Profile -- FTA-2

4.5.2.1 Chemical Results for Soil -- FTA-2

Three soil borings (02-422, 02-423, and 02-424) were drilled within the bermed fire training pit at FTA-2. One duplicate and nine investigative soil samples were retained for chemical analyses. Samples from soil boring 02-422 were collected from depths of 0 to 5 feet, 5 to 10 feet, and 25 to 29 feet BLS. Soil samples at 0 to 5 feet, 15 to 20 feet, and 20 to 25 feet BLS were collected from soil boring 02-423. The sampling intervals for soil boring 02-424 were from 1 to 4.5 feet, 10 to 15 feet, and 20 to 25 feet BLS. The soil borings were drilled and soil samples retained on 8 January 1988.

The soils were sent to WESTON/Gulf Coast Laboratories and analyzed for petroleum hydrocarbons, volatile organics, soil moisture content,and metals screen including arsenic, mercury, and selenium. No holding times were exceeded for these samples. Surrogate recoveries ranged from 85 to 107 percent for the volatile organic analyses, within acceptable quality control limits. Matrix spike recoveries for the metals screen ranged from 35 to 10,500 percent due to the low response factor of some elements (silicon) and the natural occurrence in high concentrations of others (aluminum). All detection limits for metals were within acceptable limits.

Valid analytes and concentrations detected in soil collected at FTA-2 are listed in Table 4-35. Organic compounds and petroleum hydrocarbons were detected in almost all soil samples. Soil samples 02-422-B001, 02-422-B002, 02-423-B001, 02-423-B101, and 02-424-B001 contained petroleum hydrocarbons (150 to 3,800 mg/kg), methylene chloride (not detected to 0.54 mg/kg), acetone

TABLE 4-35

VALID ANALYTES DETECTED IN SOIL AT FTA-2,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE #	02-422-B001			02-422-B002			02-422-B003			02-423-B001			02-423-B101			02-423-B002		
	RFW #	121381			121382			121383			121384			121385			121386		
	SAMPLE DATE	08-JAN-88			08-JAN-88			08-JAN-88			08-JAN-88			08-JAN-88			08-JAN-88		
	DEPTH	0-5 FEET			5-10 FEET			25-29 FEET			0-5 FEET			0-5 FEET			15-20 FEET		
	% MOISTURE	18.9			22			36.1			15.1			17.0			28.7		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
METHYLENE CHLORIDE	SW5030/SW8240	0.62		ND	0.32	0.44	=	0.008		NV	0.59	0.54	<	0.3	0.31	=	0.007		NV
ACETONE	SW5030/SW8240	1.2		ND	0.64		ND	0.016		NV	1.2	1	<	0.6	0.46	<	0.014		NV
CARBON DISULFIDE	SW5030/SW8240	0.62		ND	0.32		ND	0.008		ND	0.59		ND	0.3		ND	0.007	0.009	=
BENZENE	SW5030/SW8240	0.62		ND	0.32	0.96	=	0.008		ND	0.59		ND	0.3		ND	0.007		ND
ETHYLBENZENE	SW5030/SW8240	0.62	1.6	=	0.32	2.4	=	0.008		ND	0.59	1.8	=	0.3	0.93	=	0.007		ND
XYLENES (TOTAL)	SW5030/SW8240	0.62	7.8	=	0.32	12	=	0.008		ND	0.59	5.8	=	0.3	3.3	=	0.007		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	61.3	3100	=	66.8	150	=	78.2	84	=	58.6	3800	=	59.9	2600	=	69.4	86	=
ALUMINUM, TOTAL	SW3050/SW6010	19.2	10900	=	19.4	12300	=	19.9	15000	=	19.6	8330	=	19.9	9230	=	19.1	13200	=
ARSENIC, TOTAL	SW3050/SW7060	9.5		ND	19.2	28.2	=	10	12.6	=	9.8		ND	4.8	10.5	=	9.6	22.6	=
BORON, TOTAL	SW3050/SW6010	19.2		ND	19.4	21.1	=	19.9	30.1	=	19.6		ND	19.9		ND	19.1	24.3	=
BARIUM, TOTAL	SW3050/SW6010	2.4	75	=	2.4	144	=	2.5	125	=	2.4	59.6	=	2.5	62	=	2.4	100	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.19	0.66	=	0.19	0.65	=	0.2	0.84	=	0.2	0.42	=	0.2	0.44	=	0.19	0.74	=
CALCIUM, TOTAL	SW3050/SW6010	9.6	3300	=	9.7	30500	=	9.9	60300	=	9.8	2570	=	9.9	2400	=	9.6	41700	=
CADMIUM, TOTAL	SW3050/SW6010	0.96		ND	0.97	1.8	=	0.99	1.3	=	0.98		ND	0.99		ND	0.96	1.1	=
COBALT, TOTAL	SW3050/SW6010	3.8	7.1	=	3.9	13.9	=	4	13.4	=	3.9	5.5	=	4	6.4	=	3.8	12.7	=
CHROMIUM, TOTAL	SW3050/SW6010	1.9	18.6	=	1.9	18.9	=	2	24.5	=	2	15	=	2	17	=	1.9	20.8	=
COPPER, TOTAL	SW3050/SW6010	2.9	12	=	2.9	22.5	=	3	21.4	=	2.9	5	=	3	8.5	=	2.9	21.6	=
IRON, TOTAL	SW3050/SW6010	3.8	15600	=	3.9	27600	=	4	24900	=	3.9	12600	=	4	15900	=	3.8	23000	=
POTASSIUM, TOTAL	SW3050/SW6010	959	1160	=	970	2040	=	994	3210	=	979		ND	994		ND	957	2590	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.2	3320	=	19.4	16000	=	19.9	14000	=	19.6	2490	=	19.9	2980	=	19.1	16500	=
MANGANESE, TOTAL	SW3050/SW6010	0.96	200	=	0.97	665	=	0.99	426	=	0.98	171	=	0.99	148	=	0.96	418	=
SODIUM, TOTAL	SW3050/SW6010	86.3	1110	=	87.3	1260	=	89.5	2150	=	88.1	1050	=	89.5	1070	=	86.1	1440	=
NICKEL, TOTAL	SW3050/SW6010	4.8	17.9	=	4.8	32.9	=	5	35.5	=	4.9	13.9	=	5	16.8	=	4.8	34.1	=
SILICON, TOTAL	SW3050/SW6010	19.2	299	=	19.4	417	=	19.9	215	=	19.6	202	=	19.9	111	=	19.1	195	=
VANADIUM, TOTAL	SW3050/SW6010	3.8	24.1	=	3.9	26.5	=	4	27.9	=	3.9	18.2	=	4	25.4	=	3.8	26.6	=
ZINC, TOTAL	SW3050/SW6010	0.96	56	=	0.97	69.8	=	0.99	68.2	=	0.98	42.7	=	0.99	44.4	=	0.96	67.3	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-35

(CONTINUED)

ANALYTE	METHOD	02-423-B003 DL	R (mg/kg)	QL	02-424-B001 DL	R (mg/kg)	QL	02-424-B002 DL	R (mg/kg)	QL	02-424-B003 DL	R (mg/kg)	QL
	RFW #	121387			121388			121389			121390		
	SAMPLE DATE	08-JAN-88			09-JAN-88			09-JAN-88			09-JAN-88		
	DEPTH	20-25 FEET			1-4.2 FEET			10-15 FEET			20-25 FEET		
	% MOISTURE	34.5			16.5			28.2			37.1		
METHYLENE CHLORIDE	SW5030/SW8240	0.008		NV	1.2		ND	0.007		ND	0.008		NV
ACETONE	SW5030/SW8240	0.015		NV	2.4	1	<	0.014		NV	0.016		NV
CARBON DISULFIDE	SW5030/SW8240	0.008		ND	1.2		ND	0.007		ND	0.008		ND
BENZENE	SW5030/SW8240	0.008		ND	1.2		ND	0.007		ND	0.008		ND
ETHYLBENZENE	SW5030/SW8240	0.008		ND	1.2	3.7	=	0.007		ND	0.008		ND
XYLENES (TOTAL)	SW5030/SW8240	0.008		ND	1.2	15	=	0.007		ND	0.008		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	75.6	81	=	59.3	2700	=	68.9		ND	78.7	83	=
ALUMINUM, TOTAL	SW3050/SW6010	19.7	15800	=	19.7	9400	=	19.9	11500	=	19.7	11700	=
ARSENIC, TOTAL	SW3050/SW7060	4.8	13.4	=	4.9	15.7	=	18.8	41.1	=	9.8	15.4	=
BORON, TOTAL	SW3050/SW6010	19.7	29.9	=	19.7		ND	19.9	25.5	=	19.7	25.4	=
BARIUM, TOTAL	SW3050/SW6010	2.5	130	=	2.5	73.8	=	2.5	90.4	=	2.4	99.4	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.2	0.83	=	0.2	0.74	=	0.2	0.8	=	.20	0.76	=
CALCIUM, TOTAL	SW3050/SW6010	9.9	50800	=	9.8	3190	=	9.9	37700	=	9.8	43000	=
CADMIUM, TOTAL	SW3050/SW6010	0.99	1.2	=	0.98		ND	0.99	1.3	=	.98	1.5	=
COBALT, TOTAL	SW3050/SW6010	3.9	13.3	=	3.9	12.3	=	4	12.5	=	3.9	12.1	=
CHROMIUM, TOTAL	SW3050/SW6010	2	24.1	=	2	16.8	=	2	18.8	=	2.0	19.3	=
COPPER, TOTAL	SW3050/SW6010	3	22.8	=	3	8.8	=	3	19.4	=	2.9	22.1	=
IRON, TOTAL	SW3050/SW6010	3.9	25400	=	3.9	19300	=	4	22300	=	3.9	22500	=
POTASSIUM, TOTAL	SW3050/SW6010	987	3450	=	984	991	=	993	2180	=	983.0	2590	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.7	15200	=	19.7	2870	=	19.9	13700	=	19.7	12800	=
MANGANESE, TOTAL	SW3050/SW6010	0.99	400	=	0.98	1360	=	0.99	412	=	.98	362	=
SODIUM, TOTAL	SW3050/SW6010	88.8	2050	=	88.6	986	=	89.4	1390	=	88.5	1900	=
NICKEL, TOTAL	SW3050/SW6010	4.9	35.1	=	4.9	19.3	=	5	31.8	=	4.9	34.4	=
SILICON, TOTAL	SW3050/SW6010	19.7	242	=	19.7	190	=	19.9	312	=	19.7	194	=
VANADIUM, TOTAL	SW3050/SW6010	3.9	29.7	=	3.9	23.4	=	4	22.5	=	3.9	23.7	=
ZINC, TOTAL	SW3050/SW6010	0.99	68.1	=	0.98	48.3	=	0.99	59.4	=	.98	63.4	=

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(not detected to 1.0 mg/kg), benzene (0.96 mg/kg), ethylbenzene (1.6 to 3.7 mg/kg), and xylenes (3.3 to 15 mg/kg). Soil samples collected below 10 feet (10 to 25 feet) contained lower concentrations of petroleum hydrocarbons (less than 100 mg/kg) and no detectable volatile organics. In general, the concentration of petroleum hydrocarbons decreased by a factor of 25 from 0 to 10 feet to 10 to 25 feet.

Metals detected at FTA-2 all occurred in concentrations within the naturally occurring observed range of these elements for the eastern conterminous United States (USGS Professional Paper 1270). A few elements were above background levels for Selfridge ANGB as determined by statistical study (see Table 4-20). Barium concentrations were above background levels in soil samples 02-422-B002 and 02-423-B003 (144 and 130 mg/kg). Arsenic concentrations were above background levels in soil samples 02-424-B002 and 02-422-B003 (28.2 and 41.1 mg/kg).

4.5.2.2 Chemical Results for Groundwater -- FTA-2

Three investigative and one duplicate groundwater samples were collected from shallow monitor wells 02-164, 02-165, and 02-166. Monitor well 02-166 was installed during the IRP Stage 2 investigation as an upgradient well, and monitor wells 02-164 and 02-165 were placed downgradient of the fire training area and the overflow discharge pits. Even with changing flow directions observed at the site, monitor well 02-166 can still be considered a background monitor well; the other wells are clearly downgradient.

The groundwater samples were collected on 7 April 1988 and were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable halocarbons, purgeable aromatics, petroleum hydrocarbons, alkalinity, common anions, TDS, and metals screen including arsenic, lead, mercury, and selenium. No holding times were exceeded for these samples. The three monitor wells were resampled on 3 August 1988 for nitrate/nitrite. The resampled groundwater was analyzed within holding time limits.

Surrogate recoveries for purgeable halocarbons analyses ranged from 104 to 131 percent. Surrogate recoveries for purgeable aromatics analyses ranged from 79 to 93 percent. All surrogate recoveries and detection limits were within quality control limits.

Low concentrations of petroleum hydrocarbons (1 mg/L) were detected in groundwater samples 02-164-M001, 02-165-M001, and 02-165-M101. The same groundwater samples also contained nickel (0.021 to 0.057 mg/L). Concentrations of barium (0.235 to 0.315 mg/L) and sulfate (247 to 292 mg/L) above the statistically determined background levels were detected in groundwater samples 02-165-M001, 02-165-M101, and 02-166-M001. Alkalinity

(480 to 670 mg/L), chloride (83 to 152 mg/L), and TDS (700 to 1,300 mg/L) occurred in background concentrations in each groundwater sample. The cited concentrations of TDS and sulfate are above the secondary drinking water standards (500 mg/L for TDS; 250 mg/L for sulfate). Table 4-36 lists the valid analytes and concentrations detected in groundwater samples collected at FTA-2.

4.5.2.3 Chemical Results for Surface Water -- FTA-2

Four investigative surface water samples were collected on 20 April 1988 after an extended dry period, and three surface water samples were collected on 10 May 1988 after a significant rain event. A sample was not collected at surface water station 02-506 on 10 May 1988 because of insufficient water. Surface water stations 02-508 and 02-509 were stormwater sewer locations, while surface water stations 02-506 and 02-507 were depressions that collected water in the area surrounding the site.

The surface water samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable halocarbons, purgeable aromatics, petroleum hydrocarbons, alkalinity, common anions, TDS, and metals screen including arsenic, lead, mercury, and selenium. Holding times were exceeded for TDS in samples 02-506-W001, 02-507-W001, 02-508-W001, and 02-509-W001. Surface water was resampled on 8 August 1988 (dry event) for TDS and nitrate/nitrite and on 3 August 1988 (wet event) for nitrate/nitrite. No holding times were exceeded for these samples.

Surrogate recoveries for purgeable halocarbons analyses ranged from 0 to 134 percent. Surrogate recoveries for purgeable aromatics ranged from 0 to 106 percent. Samples 02-507-W001 and 02-507-W002 were analyzed by methods E601 and E602. Due to interferences, the samples were diluted, and higher detection limits were reported for both the analyses and confirmation. Although low surrogates were recovered for these samples, the analytical results are valid. All other surrogate recoveries and detection limits were within quality control limits.

Surface water sample 02-507-W001 (dry event) contained methylene chloride (390 mg/L) and toluene (44 mg/L). Because of matrix interferences the methylene chloride was detected by the confirmation column, but not by the first column. Petroleum hydrocarbons (2 mg/L) were detected in surface water samples (dry event) 02-508-W001 and 02-509-W001. Surface water samples (dry and wet event) collected from station 02-507 contained barium (0.155 to 0.163 mg/L), chromium (0.024 mg/L), copper (0.034 mg/L), nickel (0.031 to 0.041 mg/L), lead (0.11 to 0.17 mg/L), and zinc (0.102 to 185 mg/L). In addition, sample 02-506-W001 contained zinc (0.058 mg/L) and barium (0.068 mg/L). Sulfate (0 to 45.6 mg/L) and chloride (0 to 42.4 mg/L) concentrations for dry and wet events were within background

TABLE 4-36

VALID ANALYTES DETECTED IN GROUNDWATER AT FTA-2,
IRP IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # RFW # SAMPLE DATE		02-164-M001 127693 07-APR-88			02-165-M001 127694 07-APR-88			02-165-M101 127695 DUPLICATE 07-APR-88			02-166-M001 127698 07-APR-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00	1	=	1.00	1	=	1.00	1	=	1.00		ND
BORON, TOTAL	E200.7	mg/L	.100		ND	.100	0.267	=	.100	0.225	=	.100		ND
BARIUM, TOTAL	E200.7	mg/L	.0500	0.174	=	.0500	0.315	=	.0500	0.293	=	.0500	0.235	=
CALCIUM, TOTAL	E200.7	mg/L	.200	115	=	.200	191	=	.200	197	=	.200	174	=
COPPER, TOTAL	E200.7	mg/L	0250		ND	0250	0.057	=	0250	0.041	=	0250		ND
IRON, TOTAL	E200.7	mg/L	.0400	0.149	=	.0400	0.088	=	.0400	0.079	=	.0400	0.066	=
MAGNESIUM, TOTAL	E200.7	mg/L	.200	40.5	=	.200	75.4	=	.200	76.8	=	.200	61.3	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.337	=	.0100	0.359	=	.0100	0.337	=	.0100	0.415	=
SODIUM, TOTAL	E200.7	mg/L	.900	104	=	.900	157	=	.900	118	=	.900	106	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.057	=	.0150	0.028	=	.0150	0.021	=	.0150		ND
SILICON, TOTAL	E200.7	mg/L	.300	4.43	=	.300	6.07	=	.300	6.18	=	.300	4.96	=
ZINC, TOTAL	E200.7	mg/L	.0100	0.021	=	.0100	0.021	=	.0100	0.014	=	.0100	0.027	=
ALKALINITY	A403	mg/L	10	480	=	10	660	=	10	670	=	10	480	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	700	=	10	1300	=	10	1300	=	10	930	=
	SAMPLE # RFW # SAMPLE DATE		02-164-M001 8804-033-003 07-APR-88			02-165-M001 8804-033-004 07-APR-88			02-165-M101 8804-033-005 07-APR-88			02-166-M001 8804-033-007 07-APR-88		
CHLORIDE	A429	mg/L	25	111	=	62.5	152	=	62.5	145	=	25	83	=
SULFATE	A429	mg/L	25	89	=	62.5	282	=	62.5	292	=	25	247	=

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NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

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levels established statistically for Selfridge ANGB. Surface water station 02-507 contained high concentrations of TDS (1,100 mg/L) and alkalinity (620 to 2,500 mg/L). The concentration for TDS is above the secondary drinking water standard. Nitrate/nitrite was detected at stations 02-508 (3.7 to 5.1 mg/L) and 02-509 (2.5 to 3.3 mg/L). A detailed listing of valid analytes and concentrations detected in surface water samples collected at FTA-2 is presented in Table 4-37.

4.5.3 Extent of Contamination -- FTA-2

Chemical analyses of the soils collected during the IRP Stage 2 investigation found petroleum hydrocarbons at 2,600 to 3,800 mg/kg in samples taken from the first 5 feet in soil borings at FTA-2, at 150 mg/kg in the next 5 feet, and at less than 86 mg/kg below 10 feet BLS. Acetone (<0.46 to <1.0 mg/kg), methylene chloride (0.31 to 0.44 mg/kg), benzene (0.96 mg/kg), ethylbenzene (0.93 to 3.7 mg/kg), and xylenes (3.3 to 15 mg/kg) were detected in the first 10 feet of soil, but primarily in the first 5 feet. Thus, there is some evidence of soil contamination to the full 30-foot depth of the soil borings; however, the most significant contamination occurs in the upper 5 feet. Contamination in the upper 10 feet appears to be residual saturation, with a possible pancake layer above the capillary fringe, as described in Subsection 4.2.2.4 and shown diagrammatically in Figure 4-23.

The metals screen detected a number of heavy metals in low concentrations, all within background ranges, except arsenic in samples 02-422-B002 (28.2 mg/kg), 02-423-B002 (22.6 mg/kg), and 02-424-B002 (41.1 mg/kg). These samples were collected from soil borings at a depth of 5 to 20 feet BLS. Results from these samples would indicate that they are in the leached or anaerobic zone and are fixed or immobilized.

The area of the site used for fire training exercises at FTA-2 is a pit with a radius of 60 feet. If the soil is considered to be contaminated to 30 feet, then the total volume of contaminated soil would be 339,292 cubic feet or 12,566 cubic yards. Given a typical clay soil density of 1.77 ton/cubic yard, this is equivalent to 22,242 tons. The upper 10 feet, which is the most contaminated, has a volume of 113,097 cubic feet, or 4,189 cubic yards. This is equivalent to 7,415 tons.

Soil sampled in the first 10 feet of FTA-2 contained 150 to 3,800 mg/kg petroleum hydrocarbons. Taking an average value of 1,600 mg/kg throughout the upper 10 feet, these soils would contain 10,759 kilograms, or 23,718 pounds, of petroleum hydrocarbons. Using a density of 0.80 for JP-4, this would be equivalent to 3,551 gallons. Assuming that over the 20 years of use at the site (1968 to present) a total volume of 25,000 gallons of fuel or waste residual (500 gallons/per exercise x 10 exercises/per year x 0.25 residual burned x 20 years) has been dumped into the pit, then 21,449 gallons (85.7 percent) has been

TABLE 4-37

VALID ANALYTES DETECTED IN DRY-EVENT SURFACE WATER AT FTA-2,
IRP STAGE 2, SELFRIDGE ANGB, MI

ANALYTE	SAMPLE # / RFW # / SAMPLE DATE		02-506-W001 128922 20-APR-88			02-507-W001 128923 20-APR-88			02-508-W001 128924 20-APR-88			02-509-W001 128925 20-APR-88					
	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
METHYLENE CHLORIDE	E601	ug/L	2		ND	10	ND (390)	=	2		NV	2		NV			
TOLUENE	SW5030/SW8020	ug/L	2		ND	10	44 (32)	=	2		ND	2		ND			
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.05		ND	1.03		ND	1.03	2	=	1.05	2	=			
ALUMINUM, TOTAL	E200.7	mg/L	.200		ND	.200	3.2	=	.200		ND	.200		ND			
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0100	0.026	=	.0050		ND	.0050		ND			
BORON, TOTAL	E200.7	mg/L	.100	0.101	=	.100	0.945	=	.100		ND	.100		ND			
BARIUM, TOTAL	E200.7	mg/L	.0500	0.068	=	.0500	0.163	=	.0500		ND	.0500		ND			
CALCIUM, TOTAL	E200.7	mg/L	.200	140	=	.200	148	=	.200	83.6	=	.200	91.7	=			
CHROMIUM, TOTAL	E200.7	mg/L	.0100	0.016	=	.0100		ND	.0100		ND	.0100		ND			
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250	0.034	=	.0250		ND	.0250		ND			
IRON, TOTAL	E200.7	mg/L	.0400	0.328	=	.0400	34.8	=	.0400	0.154	=	.0400	0.351	=			
POTASSIUM, TOTAL	E200.7	mg/L	5.00	15.9	=	5.00	37.4	=	5.00		ND	5.00		ND			
MAGNESIUM, TOTAL	E200.7	mg/L	.200	35.1	=	.200	39.7	=	.200	24.6	=	.200	26.2	=			
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.535	=	.0100	6.02	=	.0100	0.016	=	.0100	0.061	=			
SODIUM, TOTAL	E200.7	mg/L	.900	8.91	=	.900	38.2	=	.900	9.42	=	.900	14.6	=			
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150	0.031	=	.0150		ND	.0150		ND			
LEAD, TOTAL	E200.7	mg/L	.0050		ND	.0500	0.11	=	.0050		ND	.0050		ND			
SILICON, TOTAL	E200.7	mg/L	.300	17.6	=	.300	10.8	=	.300	3.48	=	.300	3.17	=			
ZINC, TOTAL	E200.7	mg/L	.0100	0.058	=	.0100	0.102	=	.0100		NV	.0100		ND			
ALKALINITY	A403	mg/L	10	540	=	10	620	=	10	350	=	10	340	=			
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT			
	SAMPLE # / RFW # / SAMPLE DATE		02-506-W001 8804-183-017 20-APR-88			02-507-W001 8804-183-018 20-APR-88			02-508-W001 8804-183-019 20-APR-88			02-509-W001 8804-183-020 20-APR-88					
CHLORIDE	A429	mg/L	2.5	22.3	=	2.5	42.4	=	2.5	4.4	=	2.5	12.9	=			
SULFATE	A429	mg/L	2.5	21.8	=	2.5	11.2	=	2.5	15.3	=	2.5	33.3	=			
	SAMPLE # / RFW # / SAMPLE DATE		506 STATION DRY 08-AUG-88			02-507-W001 137307 08-AUG-88			02-508-W001 137310 08-AUG-88			02-509-W001 137312 08-AUG-88			02-509-W101 137313 08-AUG-88		
NITRATE/NITRITE	E353.1	mg/L				0.1	0.1	=	0.1	3.7	=	0.2	2.5	=	0.2	2.4	=
	SAMPLE # / RFW # / SAMPLE DATE		506 STATION DRY 08-AUG-88			02-507-W021 137308 08-AUG-88			02-508-W021 137309 08-AUG-88			02-509-W021 137311 08-AUG-88					
TOTAL DISSOLVED SOLIDS	E160.1	mg/L				10	380	=	10	330	=	10	290	=			

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TABLE 4-37 (CONTINUED)

VALID ANALYTES DETECTED IN WET-EVENT SURFACE WATER AT FTA-2

	SAMPLE # / RFW # / SAMPLE DATE		506 STATION DRY 10-MAY-88			02-507-W002 130188 10-MAY-88			02-508-W002 130190 10-MAY-88			02-509-W002 130191 10-MAY-88					
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
METHYLENE CHLORIDE	E601	ug/L				150		ND	2		ND	2		ND			
TOLUENE	SW5030/SW8020	ug/L				100		ND	2		ND	2		ND			
PETROLEUM HYDROCARBONS	E418.1	mg/L				1.02		NV	1.00		NV	1.00		NV			
ALUMINUM, TOTAL	E200.7	mg/L				.200	9.44	=	.200	0.278	=	.200		ND			
ARSENIC, TOTAL	E200.7	mg/L				.0250		ND	.0050		ND	.0050		ND			
BORON, TOTAL	E200.7	mg/L				.100	1.62	=	.100		ND	.100		ND			
BARIUM, TOTAL	E200.7	mg/L				.0500	0.155	=	.0500		ND	.0500		ND			
CALCIUM, TOTAL	E200.7	mg/L				.200	48.8	=	.200	88.4	=	.200	92.5	=			
CHROMIUM, TOTAL	E200.7	mg/L				.0100	0.024	=	.0100		ND	.0100		ND			
COPPER, TOTAL	E200.7	mg/L				.0250		NV	.0250		ND	.0250		NV			
IRON, TOTAL	E200.7	mg/L				.0400	14.8	=	.0400	0.656	=	.0400	0.261	=			
POTASSIUM, TOTAL	E200.7	mg/L				5.00	153	=	5.00		ND	5.00		ND			
MAGNESIUM, TOTAL	E200.7	mg/L				.200	20.1	=	.200	23.4	=	.200	23.7	=			
MANGANESE, TOTAL	E200.7	mg/L				.0100	0.539	=	.0100	0.044	=	.0100	0.083	=			
SODIUM, TOTAL	E200.7	mg/L				.900	49.9	=	.900	9.67	=	.900	13.1	=			
NICKEL, TOTAL	E200.7	mg/L				.0150	0.041	=	.0150		ND	.0150		ND			
LEAD, TOTAL	E200.7	mg/L				.0500	0.17	=	.0050		ND	.0050		ND			
SILICON, TOTAL	E200.7	mg/L				.300	17.9	=	.300	4.55	=	.300	3.82	=			
ZINC, TOTAL	E200.7	mg/L				.0100	0.185	=	.0100		NV	.0100		NV			
ALKALINITY	A403	mg/L				10	2500	=	10	290	=	10	300	=			
TOTAL DISSOLVED SOLIDS	E160.1	mg/L				10	1100	=	10	350	=	10	410	=			
	SAMPLE # / RFW # / SAMPLE DATE		506 STATION DRY 10-MAY-88			02-507-W002 8805-386-021 10-MAY-88			02-508-W002 8805-386-022 10-MAY-88			02-509-W002 8805-386-023 10-MAY-88					
CHLORIDE	A429	mg/L				2.5		ND	2.5	9.3	=	2.5	21.4	=			
SULFATE	A429	mg/L				2.5		ND	2.5	25.9	=	2.5	45.6	=			
	SAMPLE # / RFW # / SAMPLE DATE		506 STATION DRY 03-AUG-88			02-507-W002 136819 03-AUG-88			02-508-W002 136820 03-AUG-88			02-509-W002 136821 03-AUG-88			02-509-W102 136822 03-AUG-88		
NITRATE/NITRITE	E353.1	mg/L				0.1	0.3	=	1.0	5.1	=	1.0	3.3	=	1.0	3.0	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBER IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

removed from the pit area by natural processes. Based upon calculated biodegradation half-lives and emissions rates (see Subsection 4.2), most of this removal was apparently by biodegradation and evaporation. These processes are still very active at this site (especially vaporization) as it is an active site, and residual fuel is being added to the pit every year.

The Phase II Stage 1 investigation detected petroleum hydrocarbons (1.1 to 2.4 mg/L) and total phenolics (7 to 17 ug/L) in all three original monitor wells at FTA-2, indicating that contaminants had reached the groundwater in the immediate vicinity of the pit. Two of the original monitor wells were installed directly adjacent to the pit berm. Groundwater samples collected from IRP Stage 2 monitor wells 02-164 and 02-165 contained petroleum hydrocarbons (1 mg/L). The hydrocarbons detections in these two monitor wells were the only contaminants found in FTA-2 groundwater during the IRP Stage 2 investigation.

Groundwater flow at FTA-2 was calculated to be 1.80 ft/year in a northerly direction and 1.35 ft/year in a southeasterly direction. These flow rates were used with the retardation equation (see Subsection 4.2.2.4) to calculate migration rates of some of the JP-4 constituents. The range of organic carbon contents used was 0.1 percent, which is typical of subsurface aquifers (Dragun, 1988), and 1.0 percent, which may better reflect the marshy land on which Selfridge ANGB was built.

The migration rate in the northerly direction for 1.0 percent carbon was 0.16 ft/year and 0.88 ft/year for 0.1 percent carbon. The migration rate in the southeasterly direction, based upon 1.0 percent carbon, was 0.12 ft/year and, based upon 0.1 percent carbon, was 0.66 ft/year. FTA-1 was initially used in 1968, and therefore, the maximum time for contaminant migration to have occurred is 20 years. Given undirectional flow, the contaminant plume could have a maximum extent of 3.2 to 17.6 feet in the northerly direction, or a maximum extent of 2.4 to 13.2 feet in the easterly direction.

The basewide potentiometric map shows a groundwater depression in the vicinity of FTA-2, indicating that the groundwater is being intercepted by the stormwater drainage system. Therefore, a significant portion of the groundwater flow velocity vector may be toward the sewer pipe beneath the fire training pit. A portion of the contamination in FTA-2 may be carried by the groundwater, intercepted by the storm sewers, and transported directly to the Clinton River.

The Phase II Stage 1 investigation collected two surface water samples from standing water in the burn pit. These surface water samples contained petroleum hydrocarbons (4.56 to 69 mg/L), total phenolics (96 to 147 ug/L), TOC (93 to 165 mg/L), plus benzene, toluene, and chlorinated solvents (3 to 34 ug/L).

An overflow drain along the eastern edge of the burn pit directs overflow water to shallow depressions northeast of the fire training pit. These depressions contain visible signs of contamination such as blackened soil and oily vegetation. Surface water samples collected from these depressions during the IRP Stage 2 investigation did not contain detectable concentrations of petroleum hydrocarbons. Toluene (32 to 44 ug/L) and methylene chloride (390 ug/L) were detected in the dry-event surface water sample collected from the depression at location 02-507, which confirms to some extent the visible signs of contamination.

Surface water samples 02-508-W001 and 02-509-W001 from the stormwater drainage system contained petroleum hydrocarbons (2 mg/L). These dry-event samples were collected from upgradient (02-508) and downgradient (02-509) catch basins along the 27-inch storm sewer line that lies 11 feet beneath FTA-2. Neither surface water sample collected at these stations contained petroleum hydrocarbons during the wet event. From these data it is not possible to confirm that groundwater is carrying contamination into the stormwater drainage system at FTA-2.

No analyte concentrations in soils at FTA-2 exceeded any applicable standards presented in Tables 4-24 and 4-28. Analyte concentrations in groundwater samples that exceeded applicable standards were for copper, nickel, and TDS (see Table 4-38). Copper, nickel, and TDS exceeded the potential international chemical-specific ARAR standards (see Table 4-28). Copper also exceeded the Clean Water Act standard, and nickel exceeded the EPA ambient water quality criteria.

Table 4-39 lists the analytes in surface water (dry and wet event) that exceeded applicable standards. TDS exceeded the international chemical-specific ARARs for all valid samples from dry- and wet-event sampling at FTA-2. Copper, iron, nickel, lead, and zinc concentrations also exceeded these ARAR standards. EPA ambient water quality criteria standards were exceeded for arsenic, nickel, and lead. Copper concentrations also exceeded the Clean Water Act freshwater toxicity criterion-acute standards. Lead concentrations also exceeded this standard as well as the Safe Drinking Water Act proposed MCLG.

4.5.4 Qualitative Risk Assessment -- FTA-2

Surface and subsurface contamination of soils exist at FTA-2 as well as contamination of the underlying groundwater. Contaminants of concern were identified by using the EPA indicator chemical selection process. The contaminants listed in Table 4-40 represent the highest risk chemicals found on site out of a total of 36 individual chemical species detected in the soil, groundwater, and surface water.

Table 4-38

Analyte Concentrations in FTA-2 Groundwater Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Copper		5×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
02-165-M001	5.7×10^{-2}	X	---	---	X	X	---
02-165-M101	4.1×10^{-2}	X	---	---	X	X	---
Nickel		2.5×10^{-2}	N/A	N/A	N/A	N/A	1.34×10^{-2}
02-164-M001	5.7×10^{-2}	X	---	---	---	---	X
02-165-M001	2.8×10^{-2}	X	---	---	---	---	X
TDS		2.0×10^{2}	N/A	N/A	N/A	N/A	N/A
02-164-M001	7.0×10^{2}	X	---	---	---	---	---
02-165-M001	1.3×10^{3}	X	---	---	---	---	---
02-165-M101	1.3×10^{3}	X	---	---	---	---	---
02-166-M001	9.3×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-38
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Copper		N/A	N/A	N/A	N/A	N/A
02-165-M001	5.7×10^{-2}	---	---	---	---	---
02-165-M101	4.1×10^{-2}	---	---	---	---	---
Nickel		1.54×10^{-2}	N/A	N/A	N/A	N/A
02-164-M001	5.7×10^{-2}	X	---	---	---	---
02-165-M001	2.8×10^{-2}	X	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
02-164-M001	7.0×10^{2}	---	---	---	---	---
02-165-M001	1.3×10^{3}	---	---	---	---	---
02-165-M101	1.3×10^{3}	---	---	---	---	---
02-166-M001	9.3×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-39

Analyte Concentrations in FTA-2 Surface Water Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Arsenic		N/A	N/A	N/A	N/A	N/A	2.2×10^{-5}
02-507-W001	2.6×10^{-2}	---	---	---	---	--	X
Copper		5×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
02-507-W001	3.4×10^{-2}	X	---	---	X	X	---
Iron		3×10^{-1}	N/A	N/A	N/A	N/A	N/A
02-506-W001	3.28×10^{-1}	X	---	---	---	---	---
02-507-W001	3.48×10^{1}	X	---	---	---	---	---
02-509-W001	3.51×10^{-1}	X	---	---	---	---	---
02-507-W002	1.48×10^{1}	X	---	---	---	---	---
02-508-W002	6.56×10^{-1}	X	---	---	---	---	---
Nickel		2.5×10^{-2}	N/A	N/A	N/A	N/A	1.34×10^{-2}
02-507-W001	3.1×10^{-2}	X	---	---	---	---	X
02-507-W002	4.1×10^{-2}	X	---	---	---	---	X
Lead		2.5×10^{-2}	N/A	5×10^{-2}	8.2×10^{-2}	3.2×10^{-3}	5×10^{-2}
02-507-W001	1.1×10^{-1}	X	---	X	X	X	X
02-507-W002	1.7×10^{-1}	X	---	X	X	X	X
Zinc		3×10^{-2}	N/A	N/A	N/A	N/A	N/A
02-506-W001	5.8×10^{-2}	X	---	---	---	---	---
02-507-W001	1.02×10^{-1}	X	---	---	---	---	---
02-507-W002	1.85×10^{-1}	X	---	---	---	---	---
IDS		200	N/A	N/A	N/A	N/A	N/A
02-507-W021	3.8×10^{2}	X	---	---	---	---	---
02-508-W001	3.3×10^{2}	X	---	---	---	---	---
02-509-W021	2.9×10^{2}	X	---	---	---	---	---
02-507-W002	1.1×10^{3}	X	---	---	---	---	---
02-508-W002	3.5×10^{2}	X	---	---	---	---	---
02-509-W002	4.1×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and
.inc r (

Table 4-39
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Arsenic		2.5×10^{-5}	N/A	N/A	N/A	N/A
02-507-W001	2.6×10^{-2}	X	---	---	---	---
Copper		N/A	N/A	N/A	N/A	N/A
02-507-W001	3.4×10^{-2}	---	---	---	---	---
Iron		N/A	N/A	N/A	N/A	N/A
02-506-W001	3.28×10^{-1}	---	---	---	---	---
02-507-W001	3.48×10^{1}	---	---	---	---	---
02-509-W001	3.51×10^{-1}	---	---	---	---	---
02-507-W002	1.48×10^{1}	---	---	---	---	---
02-508-W002	6.56×10^{-1}	---	---	---	---	---
Nickel		1.54×10^{-2}	N/A	N/A	N/A	N/A
02-507-W001	3.1×10^{-2}	X	---	---	---	---
02-507-W002	4.1×10^{-2}	X	---	---	---	---
Lead		5×10^{-2}	5×10^{-2}	N/A	N/A	0
02-507-W001	1.1×10^{-1}	X	X	---	---	X
02-507-W002	1.7×10^{-1}	X	X	---	---	X
Zinc		N/A	N/A	N/A	N/A	N/A
02-506-W001	5.8×10^{-2}	---	---	---	---	---
02-507-W001	1.02×10^{-1}	---	---	---	---	---
02-507-W002	1.85×10^{-1}	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
02-507-W021	3.8×10^{2}	---	---	---	---	---
02-508-W001	3.3×10^{2}	---	---	---	---	---
02-509-W021	2.9×10^{2}	---	---	---	---	---
02-507-W002	1.1×10^{3}	---	---	---	---	---
02-508-W002	3.5×10^{2}	---	---	---	---	---
02-509-W002	4.1×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-40

Contaminants of Concern at FTA-2, IRP Stage 2, Selfridge ANGB, MI

	Maximum Concentration Detected in Medium		
Contaminant	Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
Acetone	0.001		
Barium	0.144	0.315	0.163
Benzene[a]	0.00096		
Cadmium[b]	0.0018		
Carbon disulfide	0.000009		
Ethylbenzene	0.0037		
Methylene chloride[a,c]	0.00054		0.39[d]
Toluene			0.044
Xylenes	0.015		

[a]Known/suspected carcinogen (oral route).
[b]Known/suspected carcinogen (inhalation route).
[c]No Federal or state criteria exist at present for contaminant levels in groundwater or surface water.
[d]Exceed proposed EPA media protection standard.

The following potential migration pathways for movement of contaminants from FTA-2 have been identified:

- Soil --> surface water
- Soil --> groundwater
- Soil --> groundwater --> stormwater drainage system --> surface water
- Soil --> air

Records indicate that there are 1 to 25 base personnel located within 1,000 feet of the perimeter of this site on a day-to-day basis. However, FTA-2 is on the flightline, so access to the area is controlled to a certain extent. It is possible to reach the site by an indirect route, but it is unlikely that this will occur.

Based upon available data, contamination of the groundwater with chemical species other than low-level concentrations of metals is not considered to be significant. Surface water samples at this site were taken from two ponded areas. Contamination was low level, except for methylene chloride, which exceeded the EPA proposed media protection standard for a suspected carcinogen.

Surface water in the vicinity of FTA-2 is collected by the stormwater drainage system and is discharged to the Clinton River. Excess stormwater collects in shallow depressions and either evaporates or percolates into the ground. Groundwater may also be intercepted by the stormwater drainage system passing beneath the site.

Although surface soils are contaminated at the site, direct contact with these soils by human receptors is unlikely because of the location and nature of this site. Surface soil contamination may also contribute to airborne contamination, but the extent of this problem is not known at this time. It would be expected, however, that significant dilution of these airborne contaminants would occur within a short distance of the site perimeter and that the potential hazard to persons off-site from this source of exposure would be insignificant.

If base personnel were required to have day-to-day contact with this site, or if remedial activities are initiated, routes of exposure due to direct contact with contaminated surface soils must be quantified. Air monitoring data would also be required to evaluate any hazard to site personnel.

4.6 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- FIRE TRAINING AREA 1

4.6.1 Pathway Characterization and Migration Potential -- FTA-1

4.6.1.1 Subsurface Conditions -- FTA-1

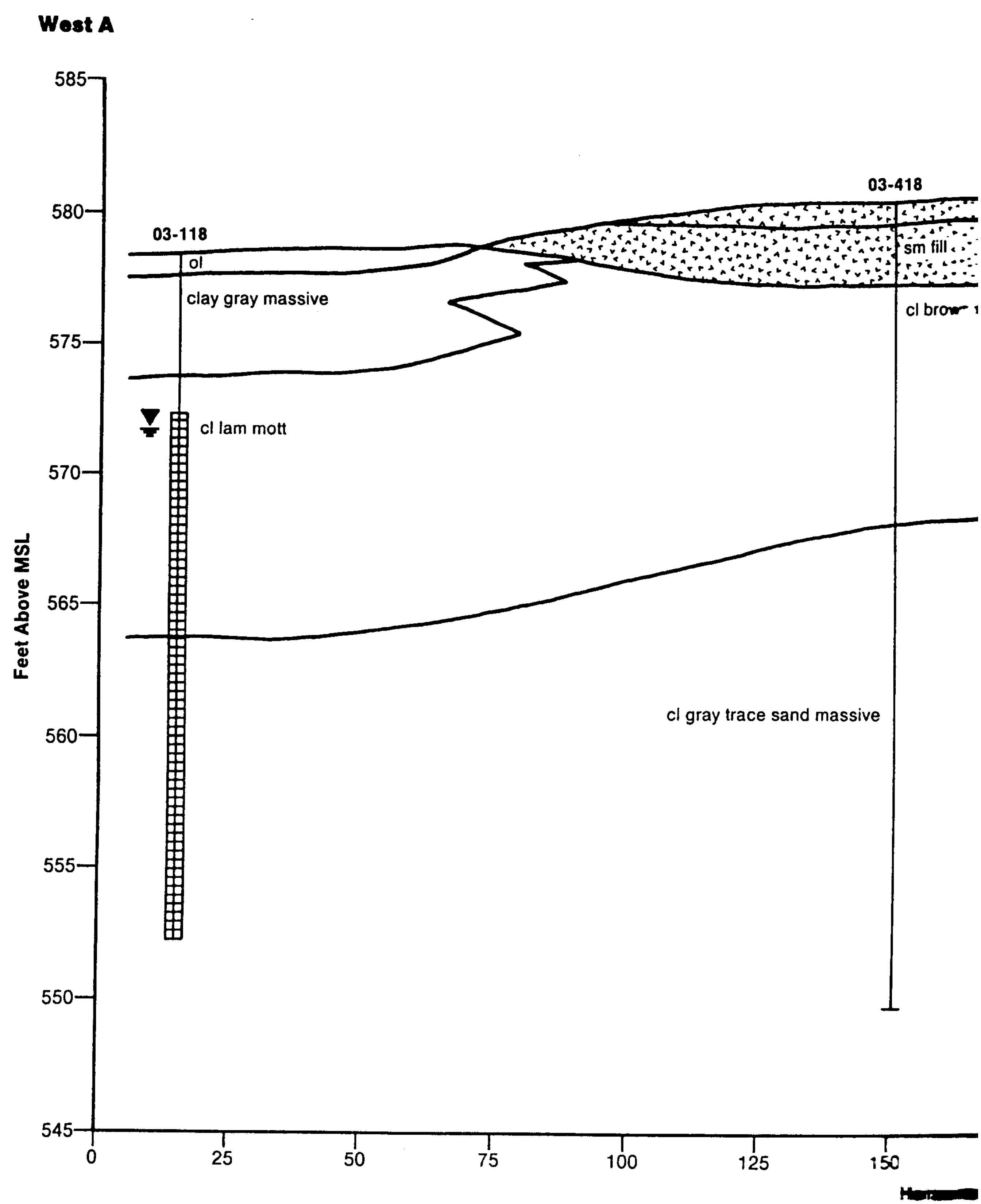
As mapped by the USDA Soil Survey (see Figure 2-5), the area around FTA-1 is composed of Made Land (Md), consisting of fill material added to the land surface. Natural surface soils appear to have been removed from the FTA-1 site and the area around it. A thin organic horizon representing the present topsoil is the only soil present at the site. This topsoil layer can be found around the periphery of FTA-1.

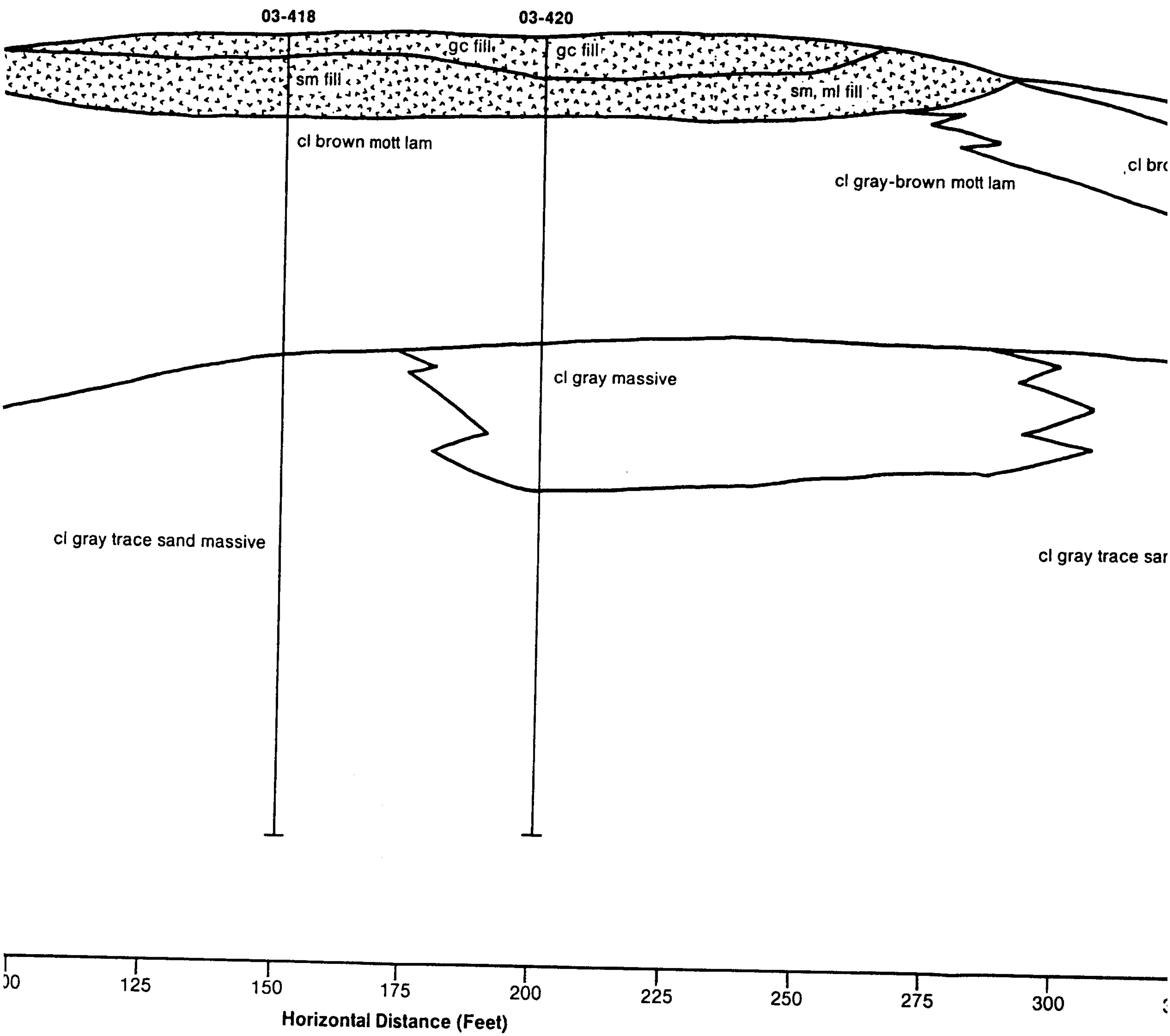
Gray clay to silty clay, with scattered thin layers and pockets of silt, was the dominant lithology encountered in the FTA-1 soil borings. From 0 to approximately 5 feet a fill layer of brown aggregate, grading downward into black silt and sand, was present. From 5 to 10 feet a brown and gray silty clay with laminations and brown mottles was observed. A gray clay to silty clay was encountered from 10 to 30 feet. The top of the saturated zone was encountered between 11 and 12 feet during drilling. Water levels stabilized at 2 to 3 feet below the ground surface after the boreholes were left open overnight, indicating possible semi-confined conditions in the saturated soils underlying the site.

Soil cores extracted from the soil borings at FTA-1 displayed consistently elevated OVA readings. The highest readings detected in soil samples were at boring 03-419. The 0- to 5-foot core registered 10 to 100 units; the 20- to 25-foot core registered 10 to 40 units; and the 25- to 30-foot core registered 20 to 30 units. The highest readings detected in vapors emanating from the soil borings were at borehole 03-418. The 5- and 10-foot intervals in this borehole registered OVA readings of greater than 1,000 units. Vapors from the borehole in 03-419 registered 100 to 200 units at the 5-foot interval and 90 to 100 at the 10-foot interval. Background OVA readings at FTA-1 were 1 unit. A petroleum odor was detected from near the bottom of the 0- to 5-foot soil core from soil boring 03-420.

4.6.1.2 Extent and Character of Unsaturated Zone -- FTA-1

A cross section prepared from subsurface data at the site shows that there is a layer of fill material 0 to 3 feet thick immediately beneath FTA-1 (see Figure 4-38). The trace of this cross section is shown in Figure 4-39. The fill material consists of a mixture of gravel, sand, and silt. A black staining was observed on the fill material within the first 5 feet of the soil borings. Unsaturated conditions occur to a depth of approximately 12 feet. In addition to the fill material, natural clays and silty clays are found within the unsaturated zone.


West A
03-118
03-418
ol
clay gray massive
cl lam mott
sm fill
cl brow
cl gray trace sand massive
Feet Above MSL
585
580
575
570
565
560
555
550
545
0
25
50
75
100
125
150


03-418
03-420
gc fill
gc fill
sm fill
sm, ml fill
cl brown mott lam
cl gray-brown mott lam
cl bro
cl gray massive
cl gray trace sand massive
cl gray trace sar
00
125
150
175
200
225
250
275
300
Horizontal Distance (Feet)

FIGURE

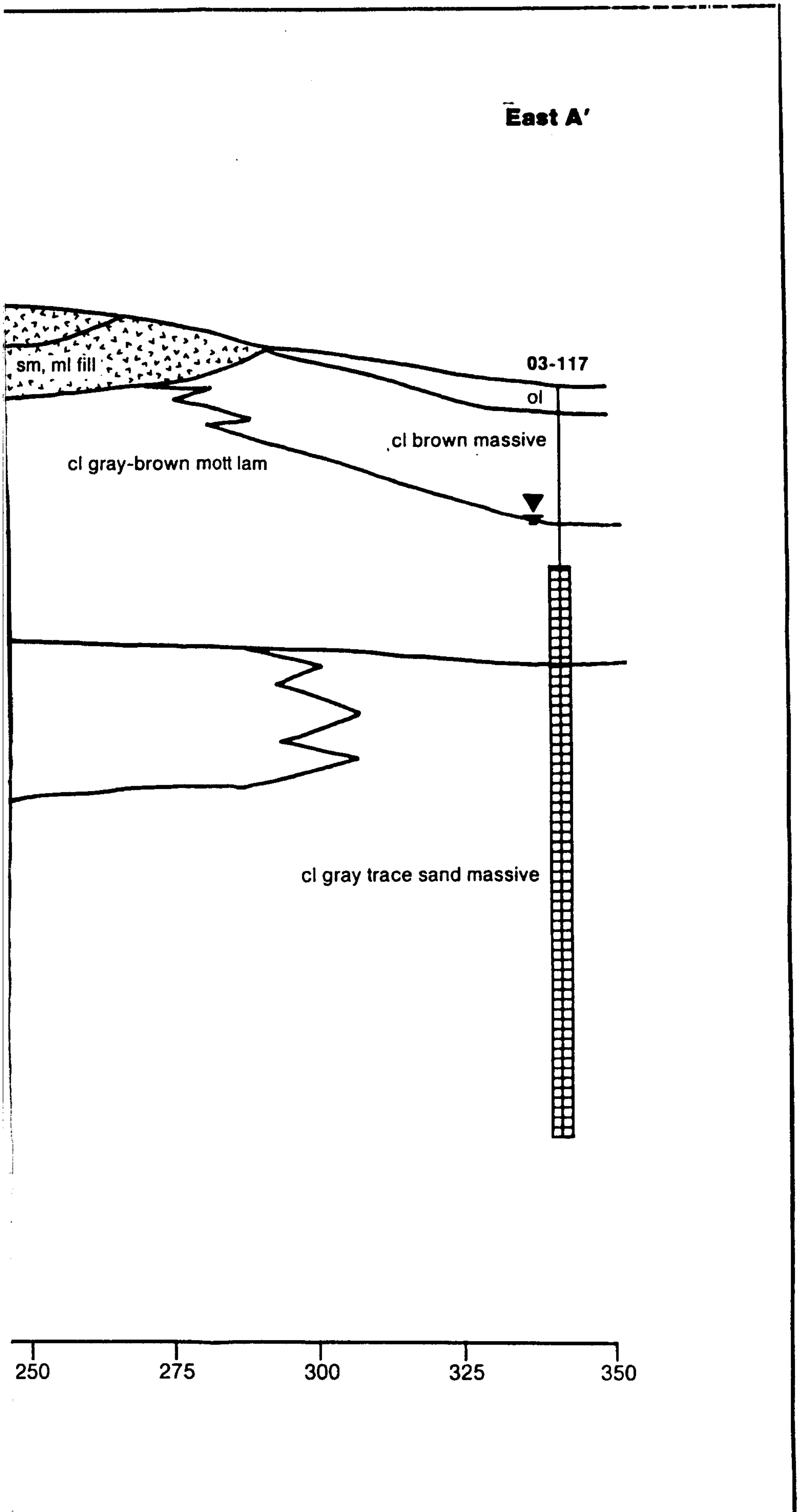
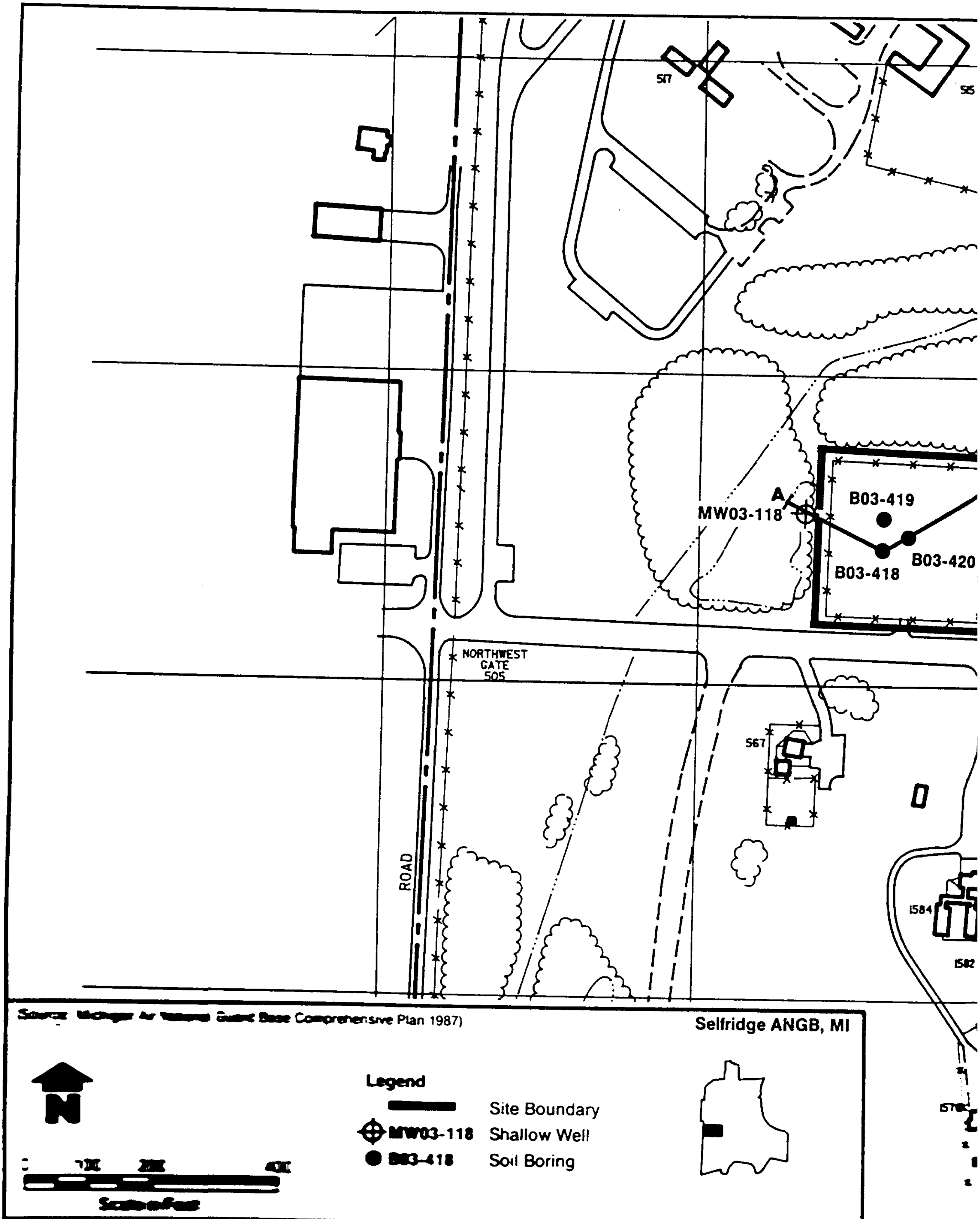


FIGURE 4-38 FTA-1 GEOLOGIC CROSS SECTION A-A'


517
515
A
MW03-118
B03-419
B03-418
B03-420
NORTHWEST
GATE
505
567
ROAD
1584
1582
Comprehensive Plan 1987)
Selfridge ANGB, MI
N
Legend
Site Boundary
MW03-118 Shallow Well
Soil Boring

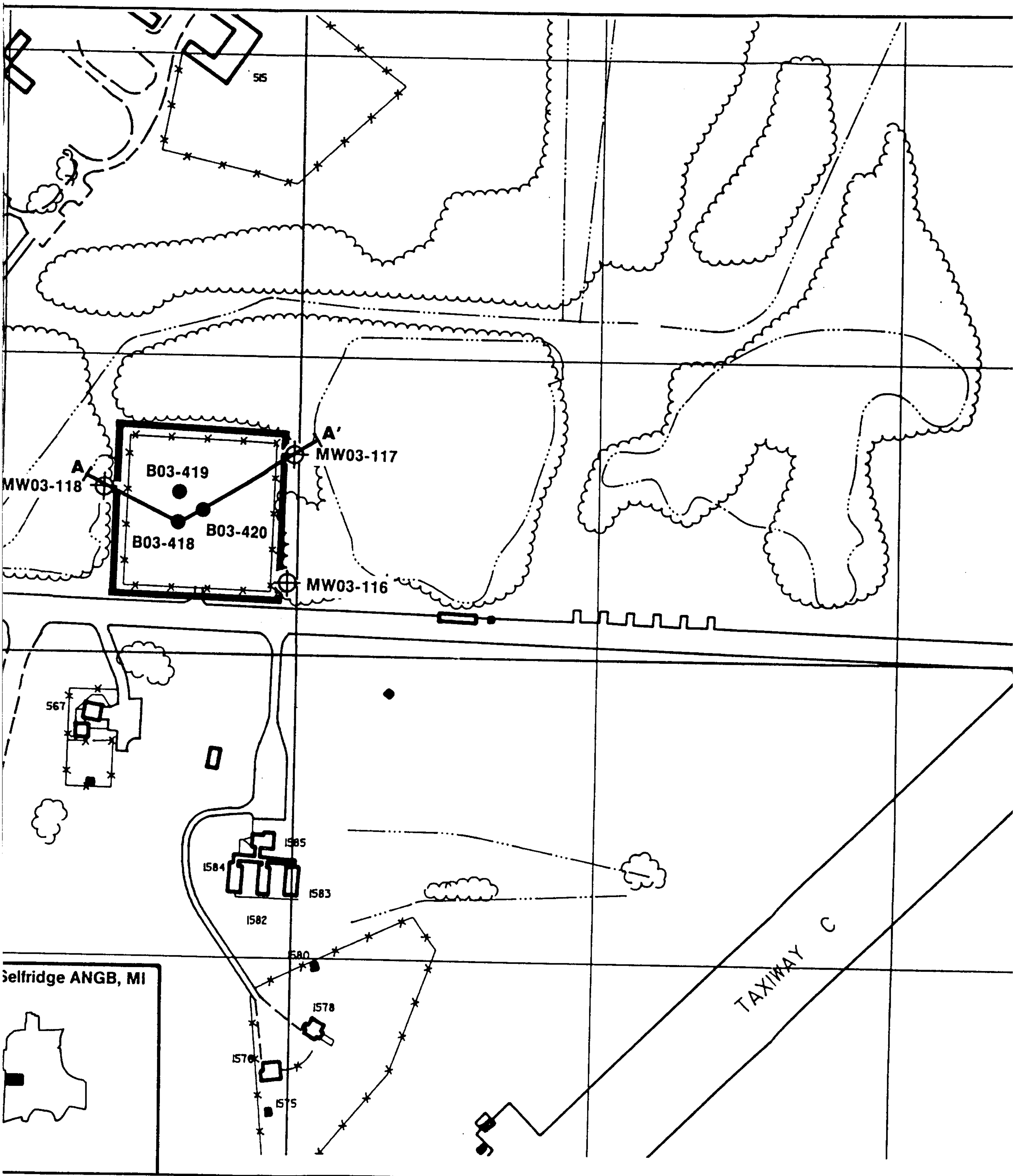


FIGURE 4-39 TRA
A-A'

FIGURE 4-39 TRACE OF CROSS SECTION A-A' AT FTA-1

Brown to gray mottling was observed within the clay and was used along with saturated conditions for determining the top of the water table.

The silty clay found beneath FTA-1 represents the upper portion of the lacustrine unit. Lamination in the lacustrine clays was observed from approximately 3 to 12 feet BLS. The fill and the natural material observed in the unsaturated zone were described as firm to stiff, based upon field observation of the plastic limits. Moist conditions existed throughout the unsaturated profile.

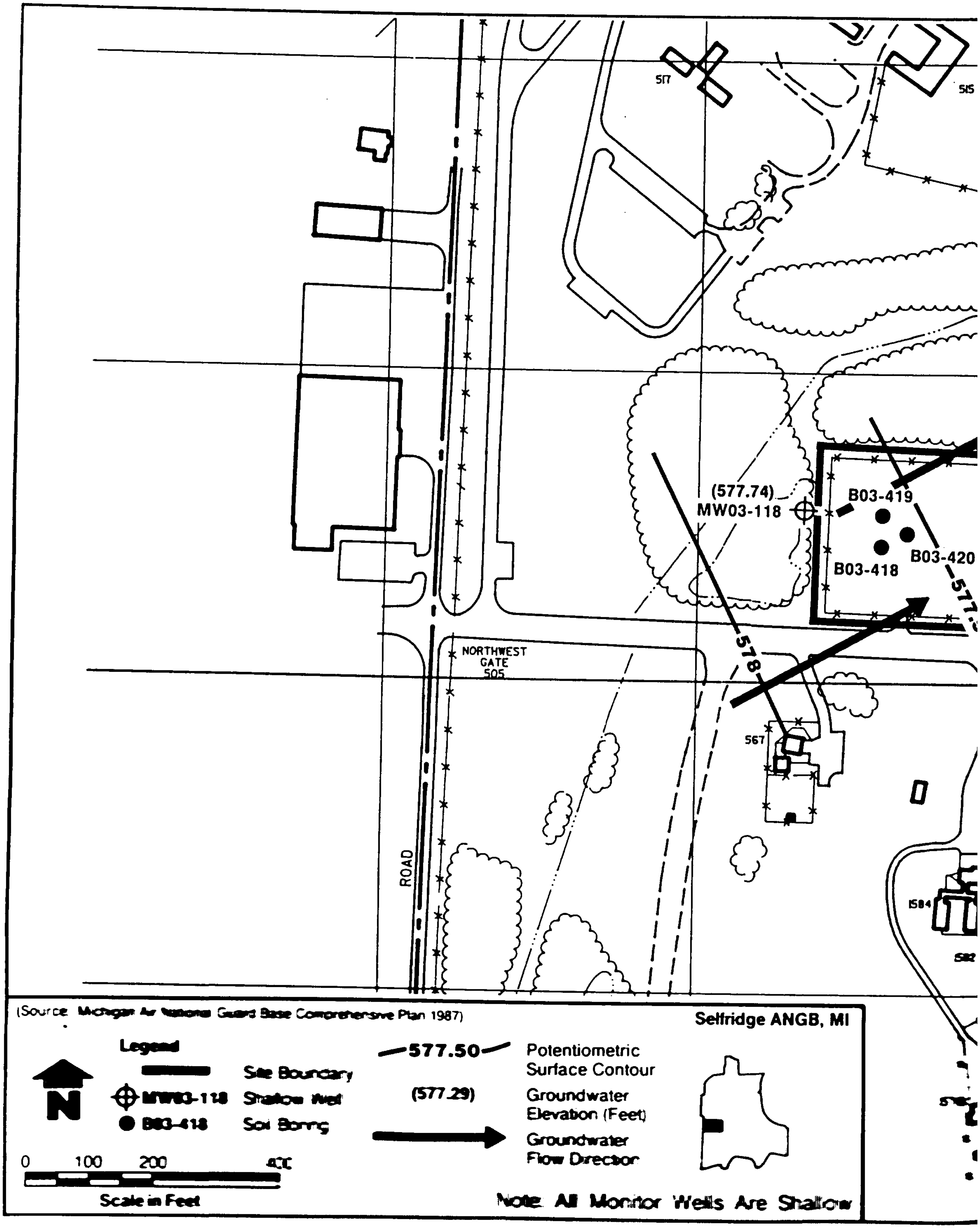
4.6.1.3 Groundwater Conditions -- FTA-1

As observed in the soil borings, the top of the saturated zone occurred between 11.5 and 13 feet BLS. The saturated zone was found to be comprised of a lacustrine gray clay to silty clay with gray mottling. A layer of unknown extent, comprised of sandy clay containing some pieces of gravel, was encountered at the base of soil boring 03-419. This layer was found to be saturated.

Potentiometric surface maps were prepared from water level data collected at each of the three monitor wells at FTA-1. Potentiometric maps were constructed for 21 March and 1 August 1988. These maps are representative of all the measurement periods. Figure 4-40 is the potentiometric surface map for 21 March 1988. Groundwater flow is to the east, based upon this map. From this period to when groundwater levels were measured on 1 August 1988, a shift in the direction of groundwater flow occurred. The potentiometric surface map for 1 August 1988 shows that groundwater flow is to the north (see Figure 4-41). Because of flat gradients on the potentiometric surface for each measurement period, small changes in water levels will result in changes in groundwater flow direction.

The groundwater velocity can be calculated from the hydraulic conductivity (K), the gradient, and the effective porosity of the soils. The groundwater gradient on 21 March 1988 was approximately 0.002 ft/ft. On 1 August 1988 the approximate groundwater gradient was 0.005 ft/ft. This increase in gradient is in response to the seasonal changes in the hydraulic regime.

The average hydraulic conductivity (K) is 4.32×10^{-5} ft/sec (1.32×10^{-3} cm/sec) for the monitor wells at FTA-1. This value is notably higher than the average hydraulic conductivity for the base. The effective porosity was assumed to be approximately 15 percent. For 21 March 1988 the groundwater velocity was calculated to be 5.77×10^{-7} ft/sec (18.2 ft/year). The groundwater flow velocity for 1 August 1988 was calculated to be 1.44×10^{-6} ft/sec (45.4 ft/year).



517
515
(577.74)
MW03-118
B03-419
B03-418
B03-420
577
578
NORTHWEST
GATE
505
567
ROAD
1584
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
N
Site Boundary
MW03-118 Shallow Well
B03-418 Soil Boring
577.50 Potentiometric Surface Contour
(577.29) Groundwater Elevation (Feet)
Groundwater Flow Direction
0 100 200 400
Scale in Feet
Note: All Monitor Wells Are Shallow

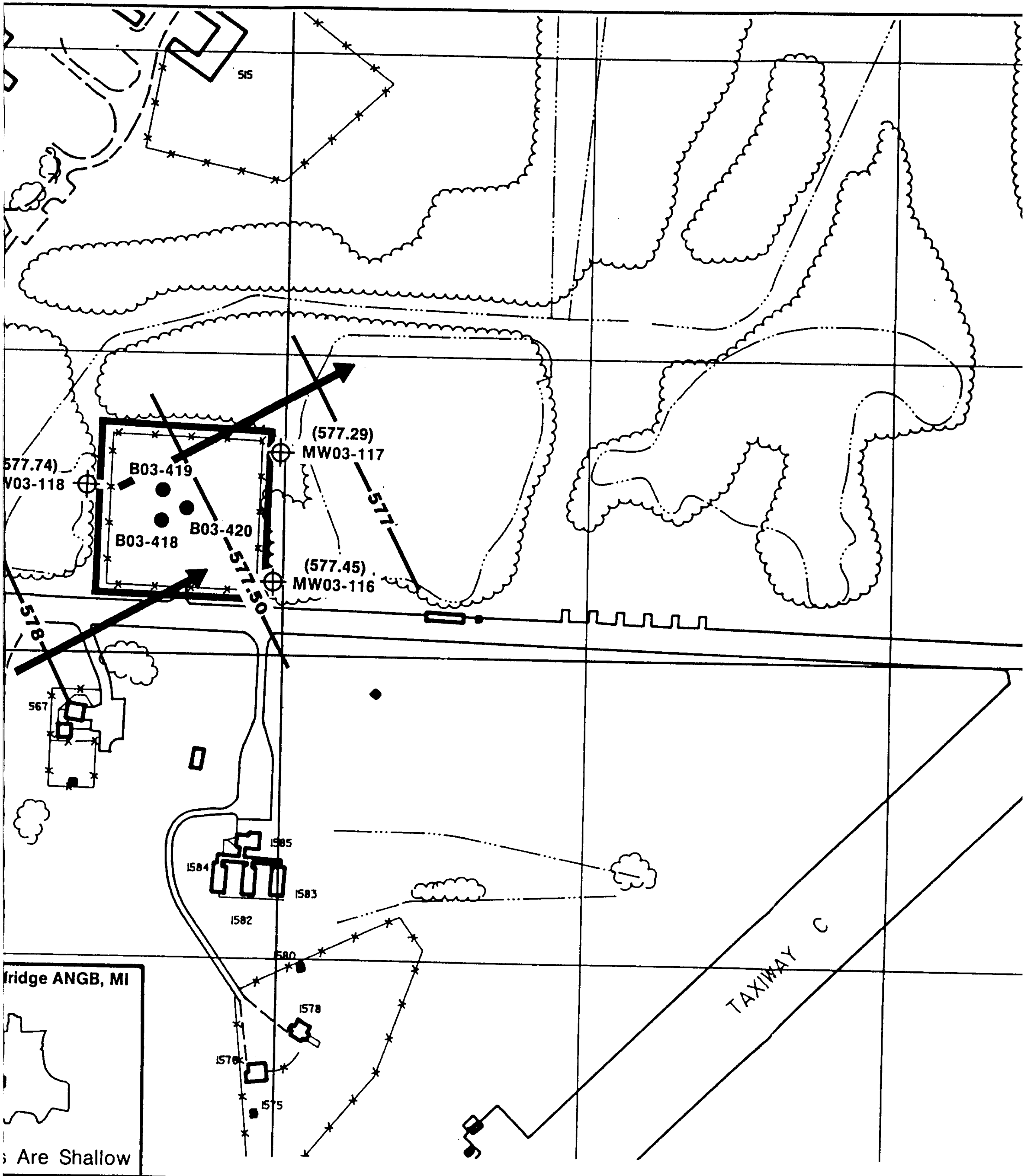


FIGURE 4-40 FTA-1 POTE
MAP ON 21

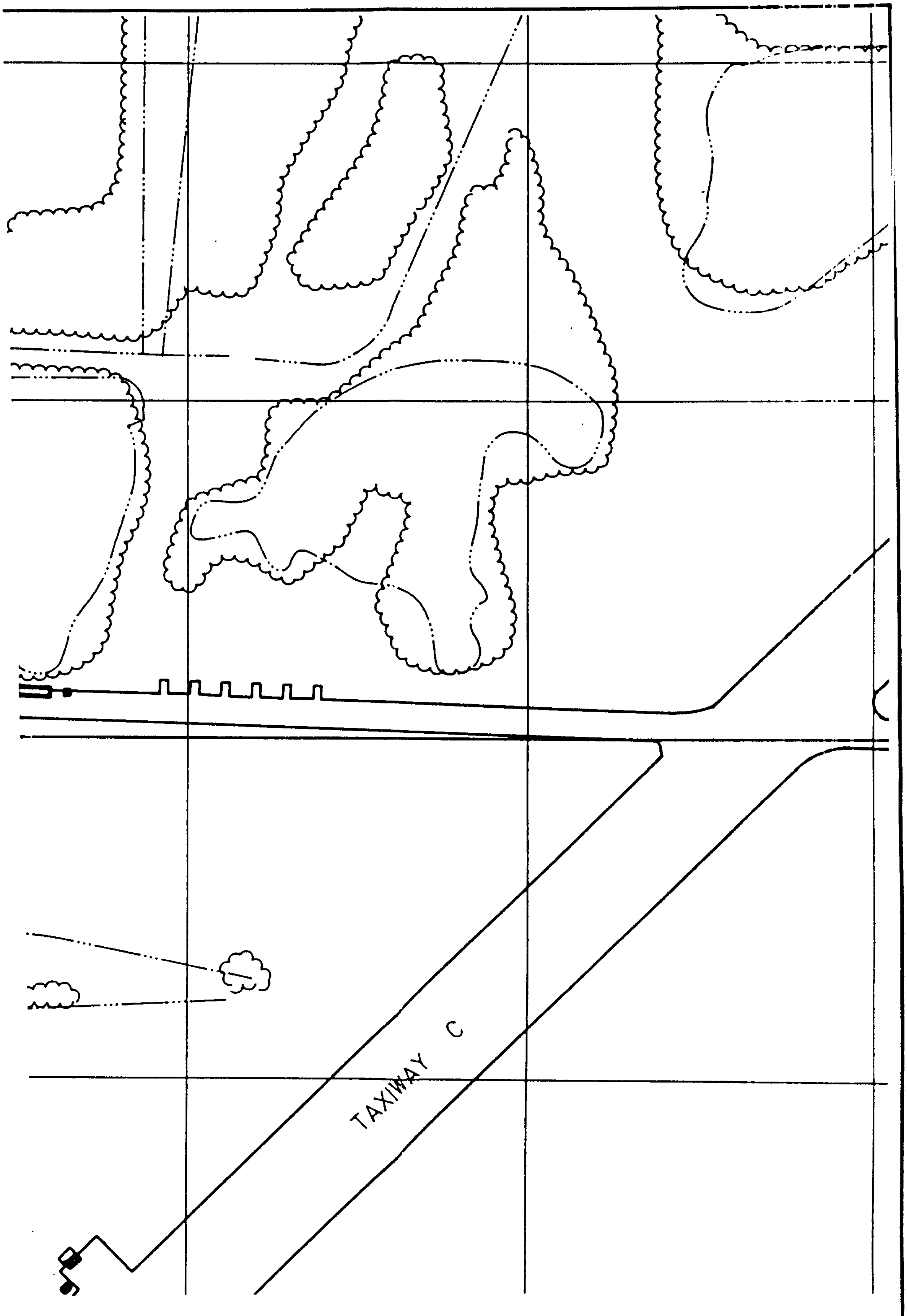
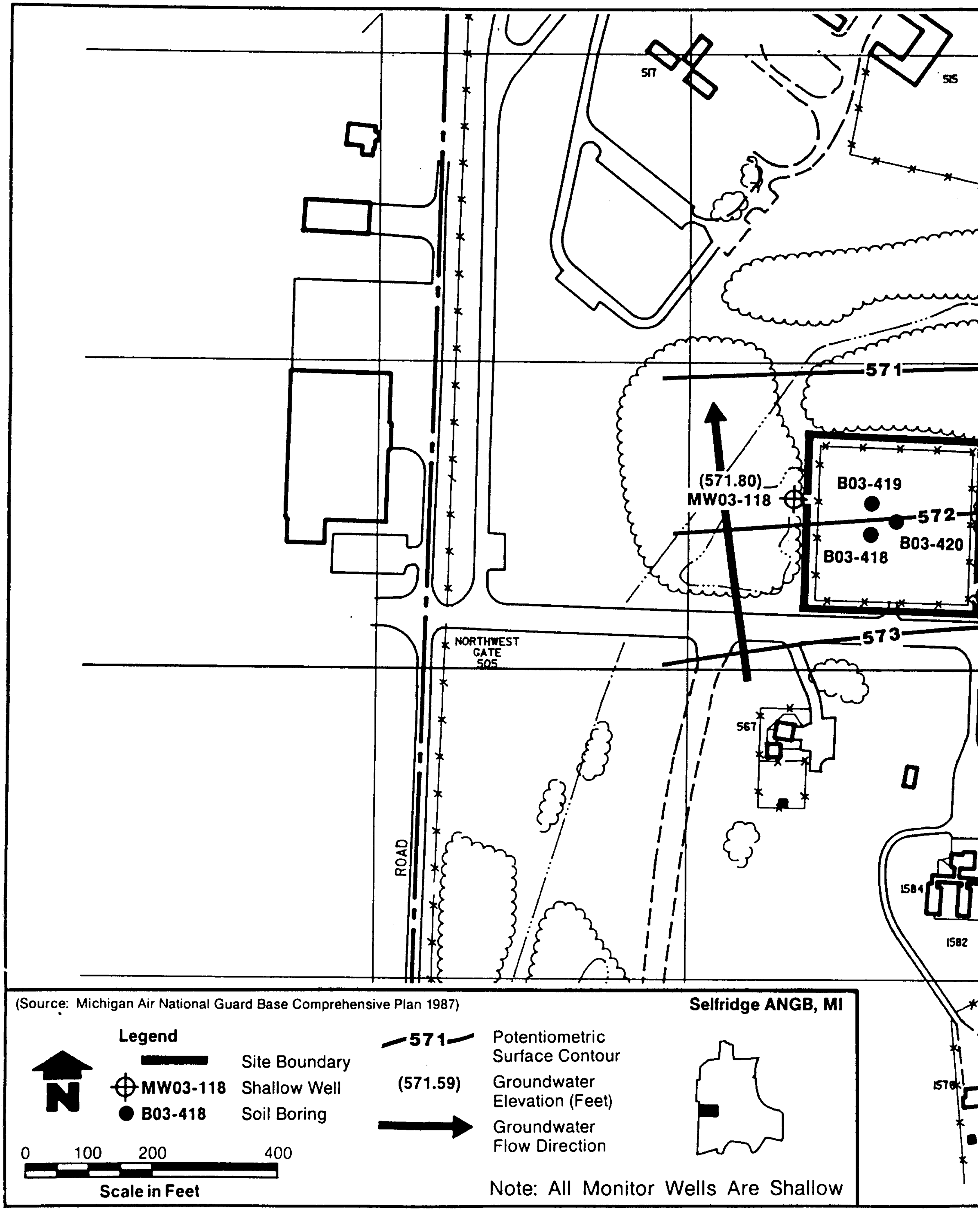


FIGURE 4-40 FTA-1 POTENTIOMETRIC SURFACE MAP ON 21 MARCH 1988



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

- Site Boundary
- MW03-118 Shallow Well
- B03-418 Soil Boring
- 571 Potentiometric Surface Contour
- (571.59) Groundwater Elevation (Feet)
- Groundwater Flow Direction

N

0 100 200 400

Scale in Feet

Note: All Monitor Wells Are Shallow

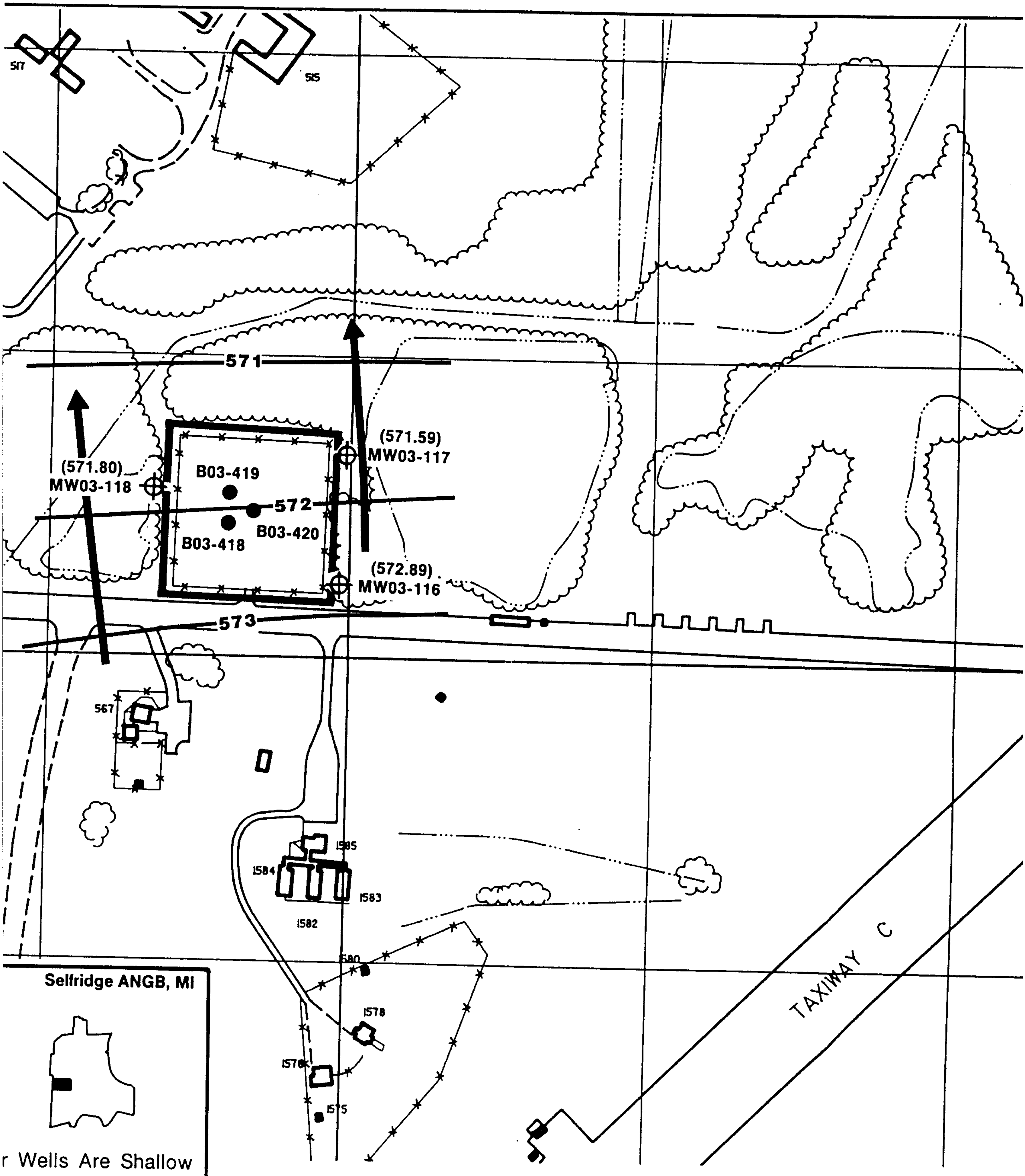


FIGURE 4-41 FTA MA

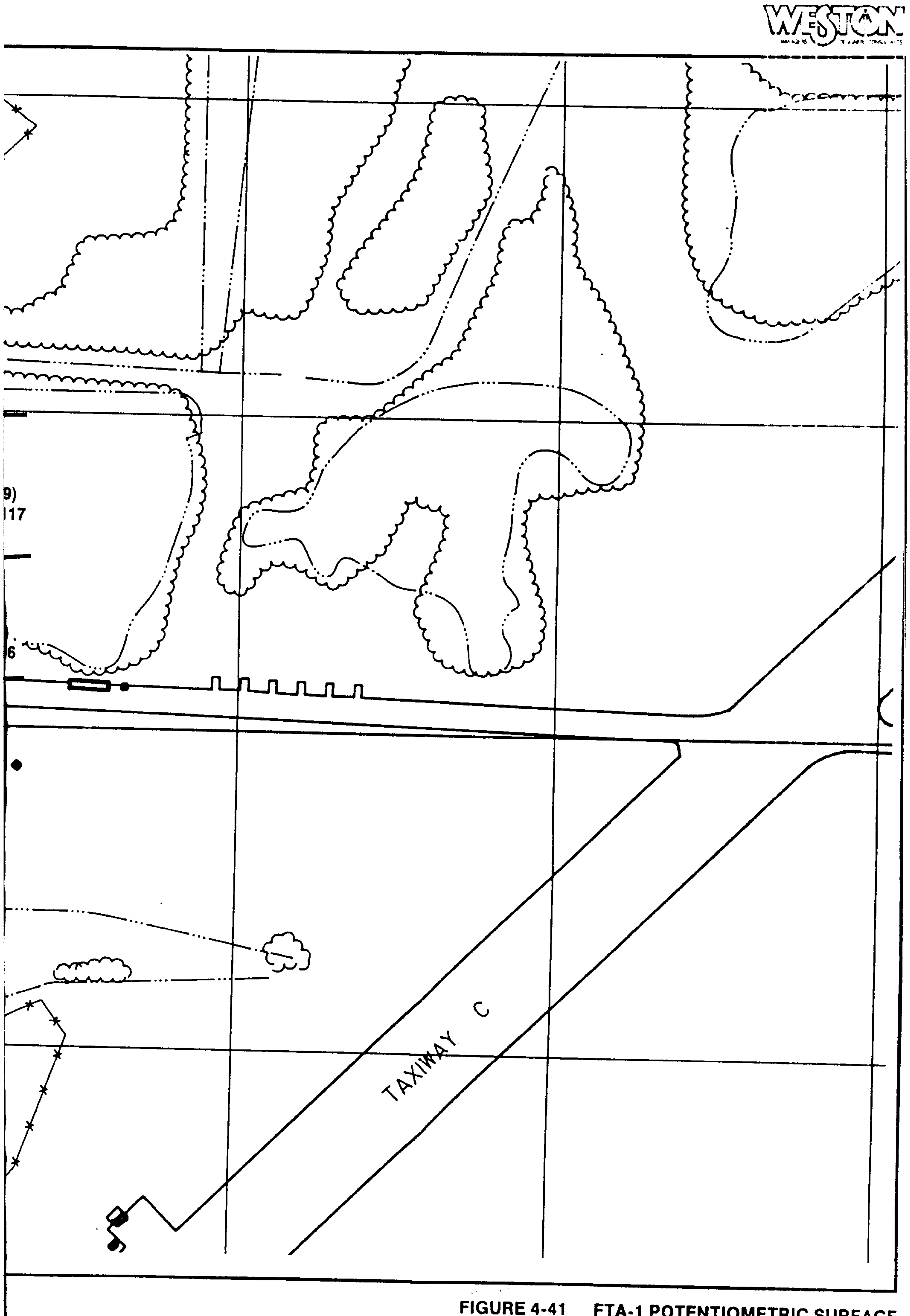


FIGURE 4-41 FTA-1 POTENTIOMETRIC SURFACE MAP ON 1 AUGUST 1988

Water levels in the monitor wells were highest between 1 February and 21 March 1988. Compared to the surface elevation of Lake St. Clair, water levels in the monitor wells for 1 February to 17 May 1988 were approximately 2 to 3.5 feet higher. A decrease in the water level occurred between 7 May and 1 August 1988. The lowest water levels were observed during the period from 20 June to 1 August 1988. For the measurement period 20 June to 1 August 1988, water levels in the monitor wells were lower than Lake St. Clair by approximately 1.3 to 2.6 feet. The occurrence of depressed water levels corresponds to a period of minimal rainfall and above-normal temperatures that increased evapotranspiration.

4.6.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- FTA-1

Fill material and the graveled surface of the impound storage lot serve as a partial cap over the abandoned FTA-1 site. Although this cap does help to prevent direct contact of precipitation with buried waste residuals at FTA-1, the effectiveness of the cap in preventing percolation to groundwater is unknown.

At present, the surface of the FTA-1 site is generally flat lying, with no mechanism for collecting and channeling surface water off the site. Excess water can pond in small local depressions on the site until percolation or evaporation takes place.

The sides of the site are grass covered and form gentle slopes that descend from the gravel-covered surface into the tree-covered area around the site. Surface water running off this site flows down the slopes and collects in the low-lying areas on the western, northern, and eastern sides. Surface water accumulation in these low-lying areas may drain off into the drainage ditch located to the west and north of the site. This ditch is connected to those along Perimeter Road, as discussed in Subsection 4.4.1.4. On the southern side of the site the slope ends at the approximate elevation of the surface of Joy Road. Runoff would move directly onto Joy Road. The stormwater drainage system does not appear to receive any runoff from FTA-1.

4.6.1.5 Direct Contact With Contaminated Media -- FTA-1

Access to the impound storage lot and former fire training pit area is controlled by a chain-link fence with a locked entry gate. Only base security personnel and military National Guard personnel have relatively unrestricted access to the area. Impoundment and removal of vehicles from this area is performed by these people on a regular basis. Authorized personnel can also gain access to this site by checking out a key for the entry gate at the base security office. Because of the chain-link fence surrounding the site, unauthorized access should be minimized. Patrol of this area by base security also helps to

prevent unauthorized entry into the site. Minimization of direct contact is also achieved by the partial cap covering the site.

4.6.1.6 Summary of Migration Pathways -- FTA-1

The cap covering FTA-1 would prevent surface water runoff from coming in contact with contaminants at the site. Therefore, surface water is not a pathway at FTA-1. Air release and direct contact with contaminants would not occur due to the presence of the cap. These pathways would also be eliminated.

Mobilization of contaminants at FTA-1 can occur as precipitation infiltrates through the unsaturated material in the area. Movement of groundwater to the east and north of the site, as defined by the potentiometric surface maps, could serve to disperse any contaminants that are leached by percolating rainwater. To the east of the site interception of the groundwater by the stormwater drainage system may result. Water collected by this part of the drainage network is discharged into the Clinton River.

4.6.2 Contamination Profile -- FTA-1

4.6.2.1 Chemical Results for Soil -- FTA-1

Three soil borings (03-418, 03-419, and 03-420) were drilled in FTA-1 from which nine investigative and one duplicate soil samples were retained for chemical analyses. These samples were taken from soil borings drilled through the gravel-covered impoundment lot into the area believed to be within the old bermed fire training pit. In soil boring 03-418 samples were collected at depths of 5 to 10 feet, 15 to 20 feet, and 25 to 30 feet. Samples from soil boring 03-419 were collected at 0 to 4 feet, 5 to 10 feet, and 25 to 30 feet. Sample intervals for soil boring 03-420 were at 1.7 to 5 feet, 5 to 9.3 feet, and 20 to 25 feet.

The borings were drilled and soil samples retained on 7 January 1988. The soil samples were sent to WESTON/Gulf Coast Laboratories and were analyzed for petroleum hydrocarbons, volatile organics, semivolatile organics, soil moisture content, and metals screen including arsenic, mercury, and selenium. No holding times were exceeded for these samples. Volatile organic analyses surrogate recoveries ranged from 85 to 120 percent, which is within acceptable limits. Semivolatile organic compound surrogate recoveries ranged from 17 to 81 percent, and matrix spike recoveries ranged from 36 to 89 percent. Although the surrogate recoveries and matrix spike recoveries were generally low, quantification limits for these analyses were within acceptable ranges (0.37 to 2.2 mg/kg).

Matrix spike recoveries for the metals screen ranged from 60 to 130 percent, with most recoveries in the 81 to 96 percent range.

The minimum and maximum recoveries were for silicon and cadmium, respectively. All quantification limits for metals were within acceptable limits.

Table 4-41 lists the valid analytes and concentrations detected in soil samples collected at FTA-1. Soil samples 03-418-B001 and 03-418-B101 contained vinyl chloride (0.1 to 0.19 mg/kg), 1,1-dichloroethene (<0.004 mg/kg), 1,2-dichloroethene (0.19 to 0.28 mg/kg), and trichloroethene (0.036 to 0.039 mg/kg). Soil sample 03-419-B001, which was analyzed twice by the laboratory for quality control purposes, contained acetone (0.18 to 0.21 mg/kg), chloroform (<0.002), 2-butanone (0.053 to 0.072 mg/kg), chlorobenzene (0.14 to 0.17 mg/kg), ethylbenzene (0.053 to 0.061 mg/kg), xylenes (0.17 to 0.18 mg/kg), 1,3-dichlorobenzene (0.026 to 0.03 mg/kg), and 1,2-dichlorobenzene (0.028 to 0.04 mg/kg). This soil sample also contained petroleum hydrocarbons (930 to 1,400 mg/kg) and two semivolatile organic compounds -- 2,4-dimethylphenol (0.41 mg/kg) and phenanthrene (<0.33 to 0.43 mg/kg). Soil samples 03-418-B002, 03-418-B003, and 03-419-B003 contained trace concentrations of 1,1,1-trichloroethane (0.01 to 0.014 mg/kg). Soil sample 03-419-B002 contained 0.064 mg/kg acetone. Soil boring 03-420 contained petroleum hydrocarbons at each sampling depth: 700 mg/kg at 1.7 to 5.0 feet (B001), 1,000 mg/kg at 5 to 9.3 feet (B002), and 230 mg/kg at 20 to 25 feet (B003). In addition, soil sample 03-420-B002 contained 2-butanone (<0.01 mg/kg) and benzene (0.006 mg/kg). Acetone (0.12 mg/kg), 2-butanone (0.027 mg/kg), and 12 semivolatile organic compounds were detected in sample 03-420-B001 at <0.33 mg/kg to 1.7 mg/kg. The semivolatile organics detected are typical of coal tar or wood preservatives often used on railroad ties. Soil sample 03-420-B003 contained acetone (0.043 mg/kg).

The metals detected in the soil samples all occurred in concentrations within the naturally occurring observed range of these elements for the eastern conterminous United States (USGS Professional Paper 1270). A few metals were above background levels for Selfridge ANGB, as determined by the statistical study (see Table 4-20). Cobalt was detected at 21.7 mg/kg in soil sample 03-419-B002, and cadmium was detected at 32.5 mg/kg in soil sample 03-420-B001, the highest concentrations detected in the soils sampled during the IRP Stage 2 investigation. Nickel was detected at 337 mg/kg in soil sample 03-420-B003, which is significantly above the statistically determined background level of 41.8 mg/kg.

4.6.2.2 Chemical Results for Groundwater -- FTA-1

Three investigative groundwater samples were collected from shallow monitor wells 03-116, 03-117, and 03-118. These three wells were placed on the perimeter of the fenced impoundment lot (FTA-1) during the IRP Phase II Stage 1 investigation.

TABLE 4-41

VALID ANALYTES DETECTED IN SOIL AT FTA-1,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE #	03-418-B001			03-418-B101			03-418-B002			03-418-B003			03-419-B001			03 419-B001		
	RFW #	121278			121279 DUPLICATE			121283			121284			121280			121281 LAB DUP		
	SAMPLE DATE	07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88		
	DEPTH	5-10 FEET			5-10 FEET			15-20 FEET			25-30 FEET			0-3.9 FEET			0-3.9 FEET		
	% MOISTURE	20.2			21.9			32.0			32.1			12.3			12.7		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
VINYL CHLORIDE	SW5030/SW8240	0.012	0.19	=	0.013	0.1	=	0.015		ND	0.015		ND	0.011		ND	0.011		ND
ACETONE	SW5030/SW8240	0.012		NV	0.013		NV	0.015		NV	0.015		NV	0.011	0.18	=	0.011	0.21	=
1,1-DICHLOROETHENE	SW5030/SW8240	0.006		ND	0.006	0.004	<	0.007		ND	0.007		ND	0.006		ND	0.006		ND
1,2-DICHLOROETHENE (TOTAL)	SW5030/SW8240	0.006	0.28	=	0.006	0.19	=	0.007		ND	0.007		ND	0.006		ND	0.006		ND
CHLOROFORM	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.007		ND	0.006	0.002	<	0.006		ND
2-BUTANONE	SW5030/SW8240	0.012		ND	0.013		ND	0.015		ND	0.015		ND	0.011	0.053	=	0.011	0.072	=
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		ND	0.006		ND	0.007	0.014	=	0.007	0.012	=	0.006		ND	0.006		ND
TRICHLOROETHENE	SW5030/SW8240	0.006	0.039	=	0.006	0.036	=	0.007		ND	0.007		ND	0.006		ND	0.006		ND
BENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.007		ND	0.006		ND	0.006		ND
CHLOROBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.007		ND	0.006	0.17	=	0.006	0.14	=
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.007		ND	0.006	0.053	=	0.006	0.061	=
XYLENES (TOTAL)	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.007		ND	0.006	0.18	=	0.006	0.17	=
1,3-DICHLOROBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.007		ND	0.006	0.03	=	0.006	0.026	=
1,2-DICHLOROBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.007		ND	0.006	0.04	=	0.006	0.028	=
2,4-DIMETHYLPHENOL	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37	0.41	=	0.38		ND
PHENANTHRENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37	0.33	<	0.38	0.43	=
ANTHRACENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
FLUORANTHENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
PYRENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
BENZO(A)ANTHRACENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
CHRYSENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
BIS(2-ETHYLHEXYL) PHTHALATE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
BENZO(B)FLUORANTHENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
BENZO(K)FLUORANTHENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
BENZO(A)PYRENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
INDENO(1,2,3-C,D)PYRENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
BENZO(G,H,I)PERYLENE	SW3550/SW8270	0.42		ND	0.41		ND	0.48		ND	0.49		ND	0.37		ND	0.38		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	62		ND	64		ND	72.4		ND	72.9		ND	56.4	1400	=	57	930	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-41

(CONTINUED)

	SAMPLE #	03-419-B002			03-419-B003			03-420-B001			03-420-B002			03-420-B003		
	RFW #	121282			121285			121286			121287			121288		
	SAMPLE DATE	07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88		
	DEPTH	5-9.2 FEET			25-30 FEET			1.7-5.0 FEET			5-9.5 FEET			20-25 FEET		
	% MOISTURE	23.2			27.4			16.0			19.9			34.9		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
VINYL CHLORIDE	SW5030/SW8240	0.013		ND	0.014		ND	0.012		ND	0.012		ND	0.015		ND
ACETONE	SW5030/SW8240	0.013	0.064	=	0.014	0.018	=	0.012	0.12	=	0.012		NV	0.015	0.043	=
1,1-DICHLOROETHENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
1,2-DICHLOROETHENE (TOTAL)	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
CHLOROFORM	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
2-BUTANONE	SW5030/SW8240	0.013		ND	0.014		ND	0.012	0.027	=	0.012	0.01	<	0.015		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		ND	0.007	0.01	=	0.006		ND	0.006		ND	0.008		ND
TRICHLOROETHENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
BENZENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006	0.006	=	0.008		ND
CHLOROBENZENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
XYLENES (TOTAL)	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
1,3-DICHLOROBENZENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
1,2-DICHLOROBENZENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.008		ND
2,4-DIMETHYLPHENOL	SW3550/SW8270	0.43		ND	0.45		ND	0.4		ND	0.41		ND	0.5		ND
PHENANTHRENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	1.2	=	0.41		ND	0.5		ND
ANTHRACENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.33	<	0.41		ND	0.5		ND
FLUORANTHENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	1.7	=	0.41		ND	0.5		ND
PYRENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	1.2	=	0.41		ND	0.5		ND
BENZO(A)ANTHRACENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.78	=	0.41		ND	0.5		ND
CHRYSENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.76	=	0.41		ND	0.5		ND
BIS(2-ETHYLHEXYL) PHTHALATE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.65	=	0.41		ND	0.5	0.14	<
BENZO(B)FLUORANTHENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.65	=	0.41		ND	0.5		ND
BENZO(K)FLUORANTHENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.37	<	0.41		ND	0.5		ND
BENZO(A)PYRENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.73	=	0.41		ND	0.5		ND
INDENO(1,2,3-C,D)PYRENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.7	=	0.41		ND	0.5		ND
BENZO(G,H,I)PERYLENE	SW3550/SW8270	0.43		ND	0.45		ND	0.4	0.68	=	0.41		ND	0.5		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	63.8		ND	68.5		ND	58.9	700	=	61.8	1000	=	75.7	230	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-41

(CONTINUED)

	SAMPLE #	03-418-B001			03-418-B101			03-418-B002			03-418-B003			03-419-B001			03-419-B001		
	RFW #	121278			121279			121283			121284			121280			121281 LAB DUP		
	SAMPLE DATE	07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88		
	DEPTH	5-10 FEET			5-10 FEET			15-20 FEET			25-30 FEET			0-3.9 FEET			0-3.9 FEET		
	% MOISTURE	20.2			21.9			32.0			32.1			12.3			12.7		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ALUMINUM, TOTAL	SW3050/SW6010	19	11600	=	19.2	12900	=	19.2	14300	=	19.3	15900	=	18.6	2930	=	19.2	2660	=
ARSENIC, TOTAL	SW3050/SW7060	19.4		ND	9.8	20.3	=	18.9	24.4	=	9.5		ND	2.5		ND	2.3		ND
BORON, TOTAL	SW3050/SW6010	19		ND	19.2	20.9	=	19.2	25.6	=	19.3	28.5	=	18.6		ND	19.2		ND
BARIUM, TOTAL	SW3050/SW6010	2.4	89	=	2.4	95.5	=	2.4	119	=	2.4	117	=	2.3	10.6	=	2.4	8.4	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.19	0.61	=	0.19	0.76	=	0.19	0.81	=	0.19	0.87	=	0.18		ND	0.19		ND
CALCIUM, TOTAL	SW3050/SW6010	9.5	8950	=	9.6	32800	=	9.6	38300	=	9.6	74000	=	9.3	948	=	9.6	1220	=
CADMIUM, TOTAL	SW3050/SW6010	0.95		ND	0.96		ND	0.96	1.4	=	0.96	1.2	=	0.93		ND	0.96		ND
COBALT, TOTAL	SW3050/SW6010	3.8	9	=	3.8	13.9	=	3.8	13.9	=	3.9	12.7	=	3.7		ND	3.8		ND
CHROMIUM, TOTAL	SW3050/SW6010	1.9	18.7	=	1.9	19.9	=	1.9	22.3	=	1.9	25	=	1.8	5.68	=	1.9	4.8	=
COPPER, TOTAL	SW3050/SW6010	2.8	16.9	=	2.9	22.5	=	2.9	20.7	=	2.9	18.5	=	2.8	4.43	=	2.9		ND
IRON, TOTAL	SW3050/SW6010	3.8	21100	=	3.8	25700	=	3.8	24000	=	3.9	24900	=	3.7	3650	=	3.8	3150	=
POTASSIUM, TOTAL	SW3050/SW6010	949	1060	=	962	1750	=	961	2840	=	965	3230	=	928		ND	961		ND
MAGNESIUM, TOTAL	SW3050/SW6010	19	7560	=	19.2	15900	=	19.2	16200	=	19.3	14500	=	18.6	709	=	19.2	820	=
MANGANESE, TOTAL	SW3050/SW6010	0.95	314	=	0.96	838	=	0.96	340	=	0.96	480	=	0.93	28.9	=	0.96	25.4	=
SODIUM, TOTAL	SW3050/SW6010	87.4	164	=	85.5	171	=	88.1	347	=	86.7	410	=	86.8		ND	85.3		ND
NICKEL, TOTAL	SW3050/SW6010	4.7	26.4	=	4.8	32.9	=	4.8	34.4	=	4.8	34	=	4.6		ND	4.8		ND
SILICON, TOTAL	SW3050/SW6010	19	278	=	19.2	124	=	19.2	79.4	=	19.3	38.7	=	18.6	244	=	19.2	160	=
VANADIUM, TOTAL	SW3050/SW6010	3.8	25.7	=	3.8	29.2	=	3.8	27.4	=	3.9	26.4	=	3.7	7	=	3.8	6.1	=
ZINC, TOTAL	SW3050/SW6010	0.95	51.7	=	0.96	64.5	=	0.96	63.4	=	0.96	65.3	=	0.93	10.8	=	0.96	9.6	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-41

(CONTINUE)

	SAMPLE #	03-419-B002			03-419-B003			03-420-B001			03-420-B002			03-420-B003		
	RFW #	121282			121285			121286			121287			121288		
	SAMPLE DATE	07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88			07-JAN-88		
	DEPTH	5-9.2 FEET			25-30 FEET			1.7-5.0 FEET			5-9.5 FEET			20-25 FEET		
	% MOISTURE	23.2			27.4			16.0			19.9			34.9		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ALUMINUM, TOTAL	SW3050/SW6010	19	13000	=	19.2	11000	=	19.4	8710	=	19.8	12300	=	19.8	15300	=
ARSENIC, TOTAL	SW3050/SW7060	9.4		ND	9.9		ND	4.8	5.3	=	9.4	9.8	=	9.2		ND
BORON, TOTAL	SW3050/SW6010	19		ND	19.2	24.7	=	19.4		ND	19.8		ND	19.8	26.5	=
BARIUM, TOTAL	SW3050/SW6010	2.4	122	=	2.4	73.9	=	2.4	55.5	=	2.5	80.3	=	2.5	112	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.19	0.79	=	0.19	0.73	=	0.19	0.47	=	0.2	0.75	=	0.2	0.85	=
CALCIUM, TOTAL	SW3050/SW6010	9.5	33500	=	9.6	47600	=	9.7	26100	=	9.9	24200	=	9.9	68500	=
CADMIUM, TOTAL	SW3050/SW6010	0.95	1	=	0.96	1.5	=	0.97	32.5	=	0.99	1.3	=	0.99		ND
COBALT, TOTAL	SW3050/SW6010	3.8	21.7	=	3.8	11.9	=	3.9	4.9	=	4	10.3	=	4	12.2	=
CHROMIUM, TOTAL	SW3050/SW6010	1.9	19.3	=	1.9	17.6	=	1.9	13.9	=	2	18.5	=	2	23.8	=
COPPER, TOTAL	SW3050/SW6010	2.8	20.3	=	2.9	23.4	=	2.9	12.3	=	3	21.2	=	3	18.8	=
IRON, TOTAL	SW3050/SW6010	3.8	26000	=	3.8	22600	=	3.9	12400	=	4	24100	=	4	24500	=
POTASSIUM, TOTAL	SW3050/SW6010	948	2020	=	959	2260	=	971		ND	989	1620	=	991	3310	=
MAGNESIUM, TOTAL	SW3050/SW6010	19	15700	=	19.2	13700	=	19.4	6640	=	19.8	16100	=	19.8	14000	=
MANGANESE, TOTAL	SW3050/SW6010	0.95	945	=	0.96	453	=	0.97	233	=	0.99	1240	=	0.99	434	=
SODIUM, TOTAL	SW3050/SW6010	85.2	215	=	88.2	294	=	86.2	127	=	86.8	171	=	87.2	381	=
NICKEL, TOTAL	SW3050/SW6010	4.7	35.8	=	4.8	38.1	=	4.8	14	=	4.9	30	=	5	337	=
SILICON, TOTAL	SW3050/SW6010	19	89.8	=	19.2	495	=	19.4	205	=	19.8	97.4	=	19.8	62.6	=
VANADIUM, TOTAL	SW3050/SW6010	3.8	27.3	=	3.8	22.9	=	3.9	17.5	=	4	28.5	=	4	26.4	=
ZINC, TOTAL	SW3050/SW6010	0.95	65.3	=	0.96	69.3	=	0.97	60.7	=	0.99	60.3	=	0.99	65.5	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

The groundwater samples were collected on 7 April 1988 and were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable halocarbons, purgeable aromatics, petroleum hydrocarbons, alkalinity, common anions, TDS, and metals screen including arsenic, lead, mercury, and selenium. No holding times were exceeded for these samples. The three monitor wells were resampled on 7 August 1988 for nitrate/ nitrite analyses. The resampled groundwater was analyzed within holding time limits.

Surrogate recoveries for purgeable halocarbons analyses ranged from 109 to 130 percent. Surrogate recoveries for purgeable aromatic analyses ranged from 71 to 208 percent. Matrix spike recoveries ranged from 86 to 98 percent for the purgeable halocarbons analyses and from 103 to 180 percent for purgeable aromatics. Matrix spike recoveries for the metals screen ranged from 64 to 121 percent. All surrogate and matrix spike recoveries were within quality control limits.

A complete list of valid analytes and concentrations detected in groundwater samples collected at FTA-1 is presented in Table 4-42. Petroleum hydrocarbons (1 mg/L) were detected in groundwater samples 03-116-M001 and 03-117-M001. Barium was detected in samples 03-116-M001 and 03-117-M001 (0.052 to 0.068 mg/L). These concentrations are within the background range (0 to 0.2 mg/L). Chloride (16 to 46 mg/L), sulfate (22.9 to 63 mg/L), alkalinity (550 to 570 mg/L), and TDS (610 mg/L) were detected in background concentrations in each sample. The concentrations for TDS are above the secondary drinking water standards (500 mg/L).

4.6.3 Extent of Contamination -- FTA-1

No visible features of FTA-1 remain at the site. Currently, the site serves as a storage lot for vehicles impounded or abandoned on base. Fill material has been added to the area to raise the lot above the poorly drained, low-lying ground around the site. The surface of this raised area has been covered with a layer of gravel.

Prior to the IRP Stage 2 study the former position of FTA-1 was thought to be in the approximate center of the impound storage lot underneath the fill material. Although the presence of dark-stained soils in the soil borings at FTA-1 confirms the location of the burn pit, re-examination of aerial photographs suggests that the site of the burn pit may have covered an area larger than the bermed fire training pit area at FTA-2.

Chemical analyses of the soils collected during the IRP Phase 2 investigation found petroleum hydrocarbons (700 to 1,400 mg/kg) in the first 5 feet of soil borings 03-419 and 03-420 and at 5 to 10 feet (1,000 mg/kg) and 20 to 25 feet (230 mg/kg) in soil boring 03-420. The first 5 feet of soil borings 03-419 and 03-420 also contained chlorinated benzenes (0.04 to 18 mg/kg)

TABLE 4-42

VALID ANALYTES DETECTED IN GROUNDWATER AT FTA-1,
IRP STAGE 2, SELFIRDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE		03-116-M001 127699 07-APR-88			03-117-M001 127702 07-APR-88			03-118-M001 127703 07-APR-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00	1	=	1.00	1	=	1.00		ND
BORON, TOTAL	E200.7	mg/L	.100		ND	.100	0.103	=	.100	0.184	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.068	=	.0500	0.052	=	.0500		ND
CALCIUM, TOTAL	E200.7	mg/L	.200	129	=	.200	142	=	.200	132	=
IRON, TOTAL	E200.7	mg/L	.0400	0.562	=	.0400	0.048	=	.0400		NV
MAGNESIUM, TOTAL	E200.7	mg/L	.200	43	=	.200	40.8	=	.200	48	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.279	=	.0100	0.042	=	.0100	0.073	=
SODIUM, TOTAL	E200.7	mg/L	.900	17.8	=	.900	22.5	=	.900	15.8	=
SILICON, TOTAL	E200.7	mg/L	.300	5.02	=	.300	4.95	=	.300	5.84	=
ZINC, TOTAL	E200.7	mg/L	.0100		NV	.0100		NV	.0100		NV
ALKALINITY	A403	mg/L	10	550	=	10	570	=	10	560	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	610	=	10	610	=	10	610	=
	SAMPLE # / RFW # / SAMPLE DATE		03-116-M001 8804-033-008 07-APR-88			03-117-M001 8804-033-011 07-APR-88			03-118-M001 8804-033-012 07-APR-88		
CHLORIDE	A429	mg/L	25	46	=	2.5	18.3	=	2.5	16	=
SULFATE	A429	mg/L	12.5	36.5	=	12.5	63	=	2.5	22.9	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBER IN PARENTHESES ARE VALUES DETERMINE BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

and semivolatile organic compounds (<0.33 to 1.7 mg/kg). Soil boring 03-418 contained chlorinated solvents (<0.004 to 0.28 mg/kg) in 5 to 10 feet. Trace amounts of other solvents occurred from 15 to 30 feet. The soils have been contaminated to the depth of the borings (30 feet), but fuels and waste chlorinated solvents are found primarily in the top 10 feet. The contamination in the upper 10 feet, based upon subsurface data, would appear to be a possible layer above the capillary fringe, as described in Subsection 4.2.2.4 and shown diagrammatically in Figure 4-21.

The metals screen detected a number of heavy metals in low concentrations. All metals were within background ranges, except arsenic in soil boring 03-418 from 5 to 20 feet (20.3 to 24.4 mg/kg), cadmium in soil boring 03-420 from 1.7 to 5.0 feet (32.5 mg/kg), and nickel in soil boring 03-420 from 20 to 25 feet (337 mg/kg). Metals contamination does not occur in any significant or discernible pattern, although the cadmium concentration in the upper 5 feet is the most significant and potentially of greatest concern.

If FTA-1 had been about the approximate size of FTA-2 (60-foot radius), then the total volume of contaminated soil would be approximately 12,566 cubic yards, assuming contamination to a depth of 30 feet. Using a soil density of 1.77 ton/cubic yard, approximately 22,242 tons of soil is contaminated. The upper 10 feet, which is the most contaminated, has a volume of about 4,189 cubic yards, which is equivalent to approximately 7,415 tons.

Soil sampled in the first 10 feet of FTA-1 contained 0 to 1,400 mg/kg petroleum hydrocarbons. Taking an average value of 573 mg/kg throughout the upper 10 feet, the soil would contain 3,853 kilograms (4.247 tons) of petroleum hydrocarbons. Using a density of 0.80 for JP-4, this is equivalent to 1,272 gallons. Assuming that fire training exercises over 15 years (1952 to 1967) used a total volume of 18,750 gallons of fuel or waste solvents (500 gallons/per exercise x 10 exercises/per year x 0.25 residual burned x 15 years), then 17,478 gallons (93.2 percent) was removed from the pit area by natural processes. Based upon calculated biodegradation half-lives and emissions rates (see Subsection 4.2.2.5), most of this removal occurred by biodegradation and evaporation. These processes are probably no longer removing the remnants of contamination at a measurable rate because the remaining contaminants are buried under the soil and gravel of the impoundment lot. Also, the most readily vaporized and biodegraded fractions of the contaminants have probably already been removed, leaving the more immobile and resistant constituents.

Groundwater transport may account for a portion of the contaminant removal from the pit area. The IRP Phase II Stage 1 investigation detected petroleum hydrocarbons in all three

monitor wells at FTA-1 (0.3 to 1.0 mg/L), plus phenolics (7 ug/L total) in monitor well 03-118, indicating that contaminants have reached the groundwater. Monitor wells 03-116 and 03-117 contained petroleum hydrocarbons (1 mg/L) in samples collected during the IRP Stage 2 investigation. The petroleum hydrocarbons detections in these two monitor wells were the only contamination found in FTA-1 groundwater during the IRP Stage 2 investigation. The confirmation of contamination in these two monitor wells corresponds with the calculated direction of groundwater flow to the north and east.

The groundwater flow velocity at FTA-1 was calculated to be 1.44×10^{-6} ft/sec (45.4 ft/year) to the north on 1 August 1988 and 5.77×10^{-7} ft/sec (18.2 ft/year) to the east on 21 March 1988. These flow rates were used with the retardation equation (see Subsection 4.2.2.4) to calculate migration rates of some of the constituents of JP-4 and solvents detected at FTA-1. The range of organic carbon contents used was 0.1 percent, which is typical of subsurface aquifers (Dragun, 1988) and 1.0 percent, which may better reflect the marshy land on which Selfridge ANGB was built.

The maximum migration rates (1.0 percent carbon) on 1 August 1988 for benzene and ethylbenzene ranged from 3.94 to 2.09 ft/year, respectively, and 1.58 to 0.83 ft/year, respectively, on 21 March 1988. Maximum migration rates based upon 0.1 percent carbon for benzene and ethylbenzene ranged from 8.87 to 5.91 ft/year, respectively, on 21 March 1988. Migration rates for benzene and ethylbenzene ranged from 22.13 to 14.75 ft/year, respectively, on 1 August 1988. Benzene and ethylbenzene have the fastest calculated migration rates for constituents of JP-4. FTA-1 was initially used in 1952, and therefore, the maximum duration of time for contaminant migration to have occurred is 36 years. The organic contaminant plume would have a maximum extent of 97.9 to 417 feet in an easterly direction and a maximum extent of 244 to 1,041 feet in a northerly direction.

No analyte concentrations in soils at FTA-1 exceeded any applicable standards presented in Tables 4-24 and 4-28. Analyte concentrations in groundwater which exceeded applicable standards are presented in Table 4-43. Copper concentrations in sample 02-165-M001 exceeded several standards (see Table 4-43). Nickel concentrations exceeded potential international chemical-specific ARAR standards and EPA ambient water quality criteria for two samples. Concentrations of TDS in all groundwater samples were in exceedance of the ARAR standards.

4.6.4 Qualitative Risk Assessment -- FTA-1

Sampling data available for the FTA-1 site indicate the presence of 47 individual chemical species present in soils and groundwater. No surface water areas are present, and the storm-

Table 4-43

Analyte Concentrations in FTA-1 Groundwater Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Iron		3×10^{-1}	N/A	N/A	N/A	N/A	N/A
03-116-M001	5.62×10^{-1}	X	---	---	---	---	---
TDS		2.0×10^{2}	N/A	N/A	N/A	N/A	N/A
03-116-M001	6.1×10^{2}	X	---	---	---	---	---
03-117-M001	6.1×10^{2}	X	---	---	---	---	---
03-118-M001	6.1×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreememt Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-43
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Iron		N/A	N/A	N/A	N/A	N/A
03-116-M001	5.62×10^{-1}	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
03-116-M001	6.1×10^{2}	---	---	---	---	---
03-117-M001	6.1×10^{2}	---	---	---	---	---
03-118-M001	6.1×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

water drainage system does not directly drain the site; therefore, surface water samples were not collected at this site.

Chemical species detected in groundwater at this site were low-level concentrations of metals that were not present in concentrations significantly above background. Therefore, based upon available data, groundwater is not considered to be a contaminated medium at this site.

Twenty-five individual chemical species were identified as contaminants of concern in soils using the EPA indicator chemical selection process. Many of these contaminants are associated with the combustion of fuels and solvents and include chlorinated benzenes. The contaminants of concern selected for FTA-1 are listed in Table 4-44.

The following migration pathways for movement of contaminaants from the site have been identified:

- Soil --> groundwater
- Soil --> surficial drainage ditches --> eventual discharge to surface water

FTA-1 is surrounded by a fence and currently serves as a vehicle impoundment area. It is estimated that 26 to 100 persons are within 1,000 feet of the site perimeter on a day-to-day basis.

Of the contaminants detected in site soils, only trichloroethene has an established criterion, the EPA proposed media protection standard, that can serve as a basis for an evaluation of the level of contamination. However, the maximum concentrations of this contaminant detected in site soils are 10 times lower than the proposed standard.

Because soil contamination with volatile and semivolatile contaminants is fairly low level, subsurface release of contaminants into ambient air would be slow. Exposure to airborne contaminants by inhalation at significant concentrations is unlikely due to the remote location and limited use of the site. The cap over the site also serves to downplay this pathway. However, this pathway must be evaluated if remedial activities at the site expose contaminated soils.

Additionally, if site soils are disrupted, resulting in the potential for direct contact with contaminated subsurface soils, the exposure potential by direct contact must be further evaluated. A variety of PAHs were found in soils, and most are known or suspected to be carcinogenic by dermal or ingestion routes.

Table 4-44

Contaminants of Concern at FTA-1, IRP Stage 2, Selfridge ANGB, MI

Contaminant	Maximum Concentration Detected in Medium Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
Bis(2-ethylhexyl) phthalate	0.00014		
Cadmium[a]	0.0325		
Chloroform[b]	0.000002		
Ethylbenzene	0.000061		
2,4-Dimethylphenol	0.00041		
1,1,1-Trichloroethane	0.000014		
1,2-Dichloroethene	0.00028		
Trichloroethene[b]	0.00039		
Vinyl chloride[b]	0.00019		
PAHs			
Anthracene	0.00033		
Benzo(a)anthracene[b]	0.00078		
Benzo(a)pyrene[b]	0.00073		
Benzo(b)fluoranthene[b]	0.00065		
Benzo(g,h,i)perylene	0.00068		
Benzo(k)fluoranthene[b]	0.00037		
Pyrene	0.0012		
Phenanthrene	0.0012		
Fluoranthene	0.0017		
Indeno(1,2,3-c,d)pyrene[b]	0.0007		
Chrysene[b]	0.00076		
1,2-Dichlorobenzene	0.00004		
1,3-Dichlorobenzene	0.00003		
Chlorobenzene	0.00017		
2-Butanone	0.000072		
Acetone	0.00021		

[a]Known/suspected carcinogen (inhalation route).
[b]Known/suspected carcinogen (oral route).

4.7 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- WEST RAMP

4.7.1 Pathway Characterization and Migration Potential -- WRMP

4.7.1.1 Subsurface Conditions -- WRMP

According to the USDA Soil Survey map (see Figure 2-5), no natural soils exist at or immediately around the WRMP. The surface material is mapped as Made Land (Md), which represents fill material added to the area prior to or during construction of the WRMP.

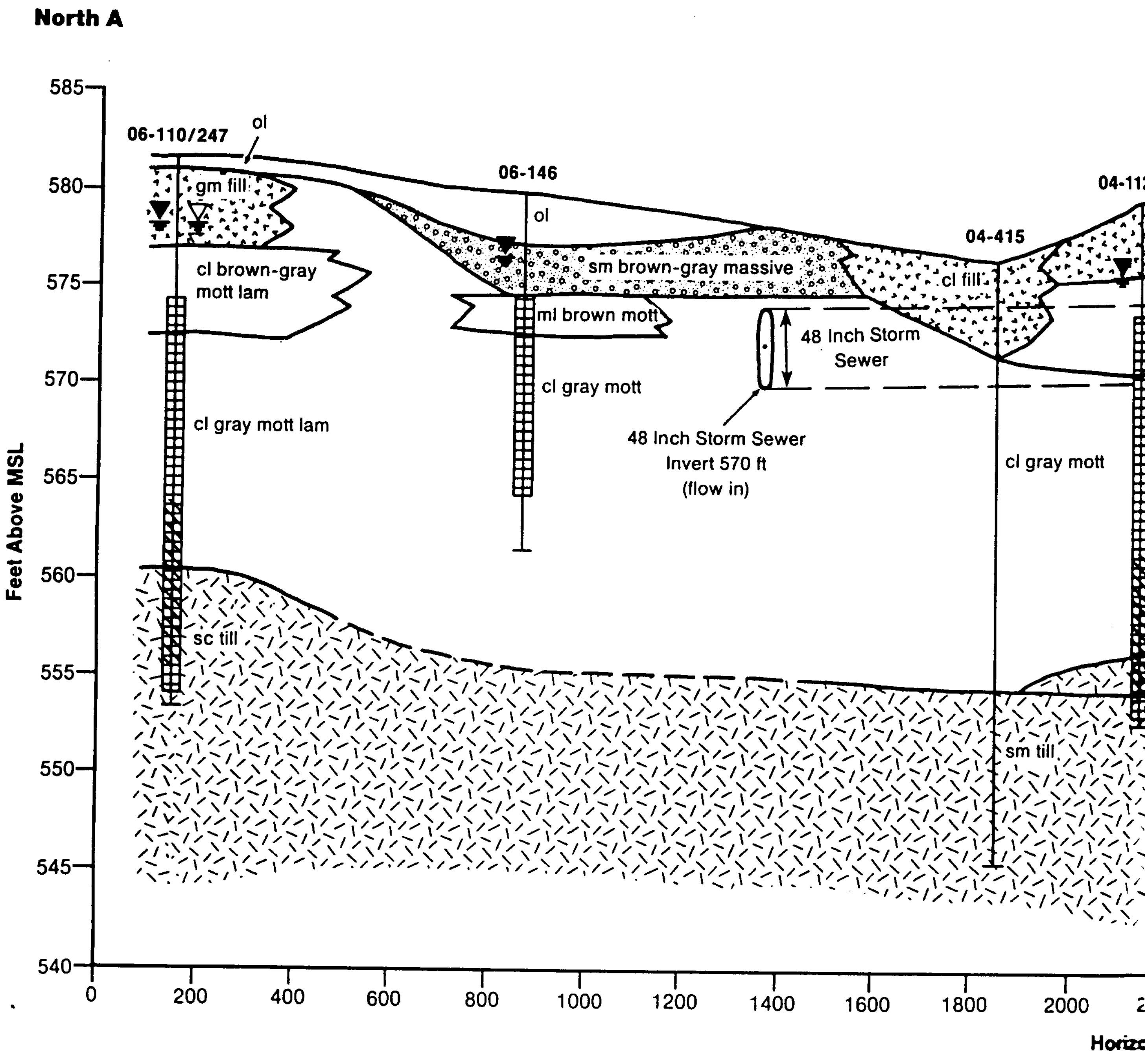
Surficial material encountered in the 10 soil borings and well borings at WRMP consisted of 4 to 5 feet of fill material, predominantly silty clay and clayey silt, as seen in Figures 4-42, 4-43, and 4-44. The trace of each cross section is presented in Figure 4-45. A thin topsoil horizon has developed on top of the fill material. Minor amounts of gravel, sand, and miscellaneous particles, including coal fragments, were also found in the fill material.

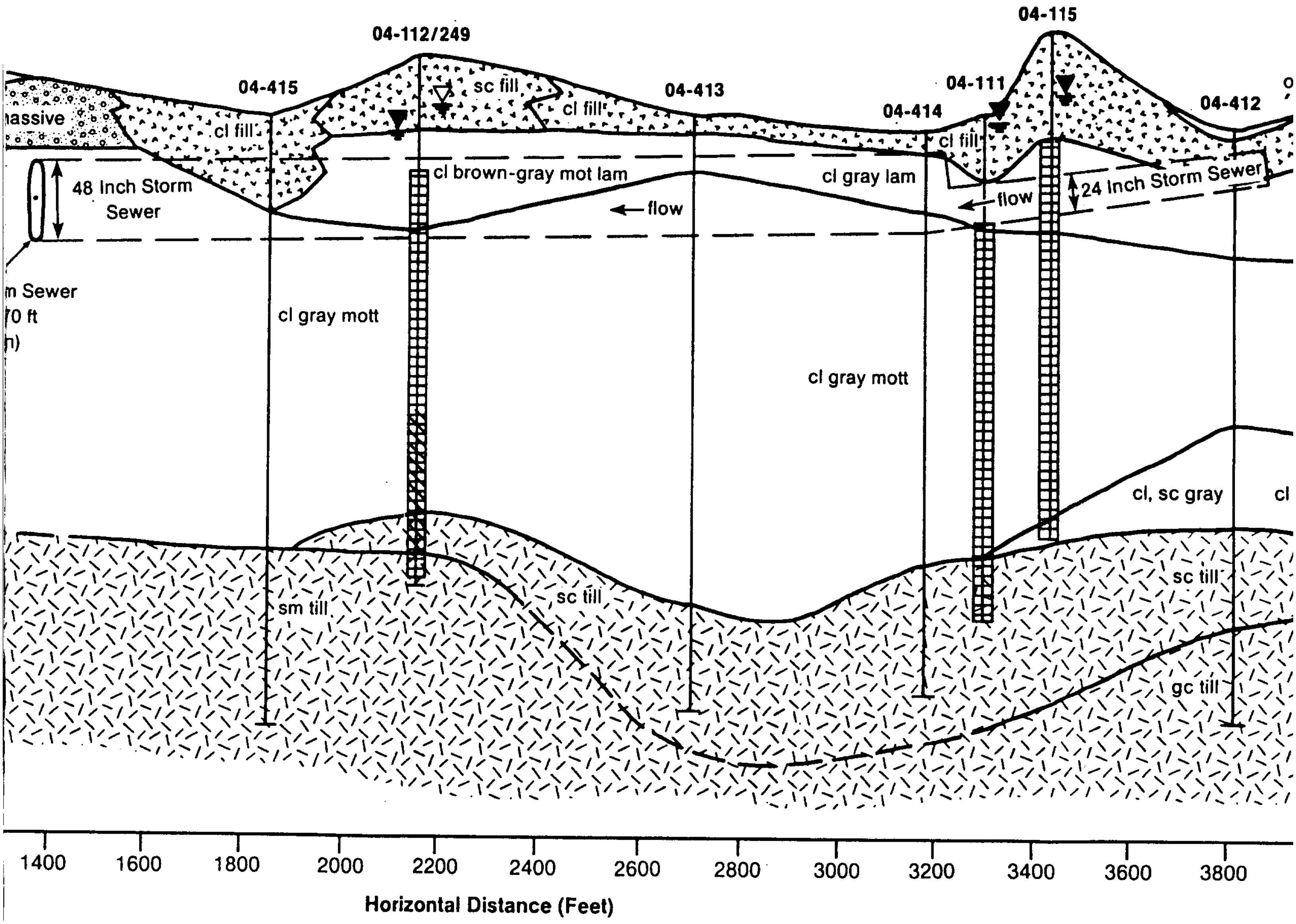
Underlying the fill material and extending to a approximate depth of between 10 and 14 feet BLS was gray and brown silty clay. Orange, brown, and gray mottling was commonly observed in the fill material and the underlying silty clay. Gray clay and silty clay was encountered beginning between 20 and 25 feet. The clays between approximately 10 to 25 feet are part of the lacustrine unit found at the base.

Underlying the clays and generally extending to the base of the soil borings at a depth of 30 feet BLS a gray clayey silt and sand with some gravel was present. This layer represents the upper transitional part of the till unit. In three of the WRMP soil borings, two on the eastern perimeter of the site (04-406 and 04-411) and one on the western perimeter (04-414), the bottom 2 to 4 feet of sediment consisted of a dense, partially cemented, silt, sand, and gravel till. This represents the lower part of the lower till unit.

The top of the saturated zone was encountered between 9 and 11 feet BLS during drilling along the eastern and northern perimeters of WRMP. Along the western perimeter the saturated zone was encountered between 5 and 7 feet BLS. Saturated conditions occurred at 12 BLS feet along the southern perimeter of the site.

Background OVA readings at WRMP were 1 unit. Soil samples extracted from WRMP soil borings above 15 feet generally did not register OVA readings in excess of background levels. Samples from below this depth typically displayed readings above background levels, and measurements up to 10 units in these samples were common. Four soil borings (04-406, 04-409, 04-411, and 04-415) produced samples that registered OVA readings of 100


North A
Feet Above MSL
585
580
575
570
565
560
555
550
545
540
0
200
400
600
800
1000
1200
1400
1600
1800
2000
06-110/247
ol
gm fill
cl brown-gray mott lam
cl gray mott lam
sc till
06-146
ol
sm brown-gray massive
ml brown mott
cl gray mott
48 Inch Storm Sewer
48 Inch Storm Sewer Invert 570 ft (flow in)
04-415
cl fill
cl gray mott
sm till
Horizo



04-112/249
04-115
04-415
04-413
04-111
04-414
04-412
sc fill
cl fill
cl fill
cl fill
assive
48 Inch Storm Sewer
cl brown-gray mot lam
cl gray lam
flow
flow
24 Inch Storm Sewer
n Sewer
0 ft
n)
cl gray mott
cl gray mott
cl, sc gray
cl
sm till
sc till
sc till
gc till
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
Horizontal Distance (Feet)

FIGURE 4-4

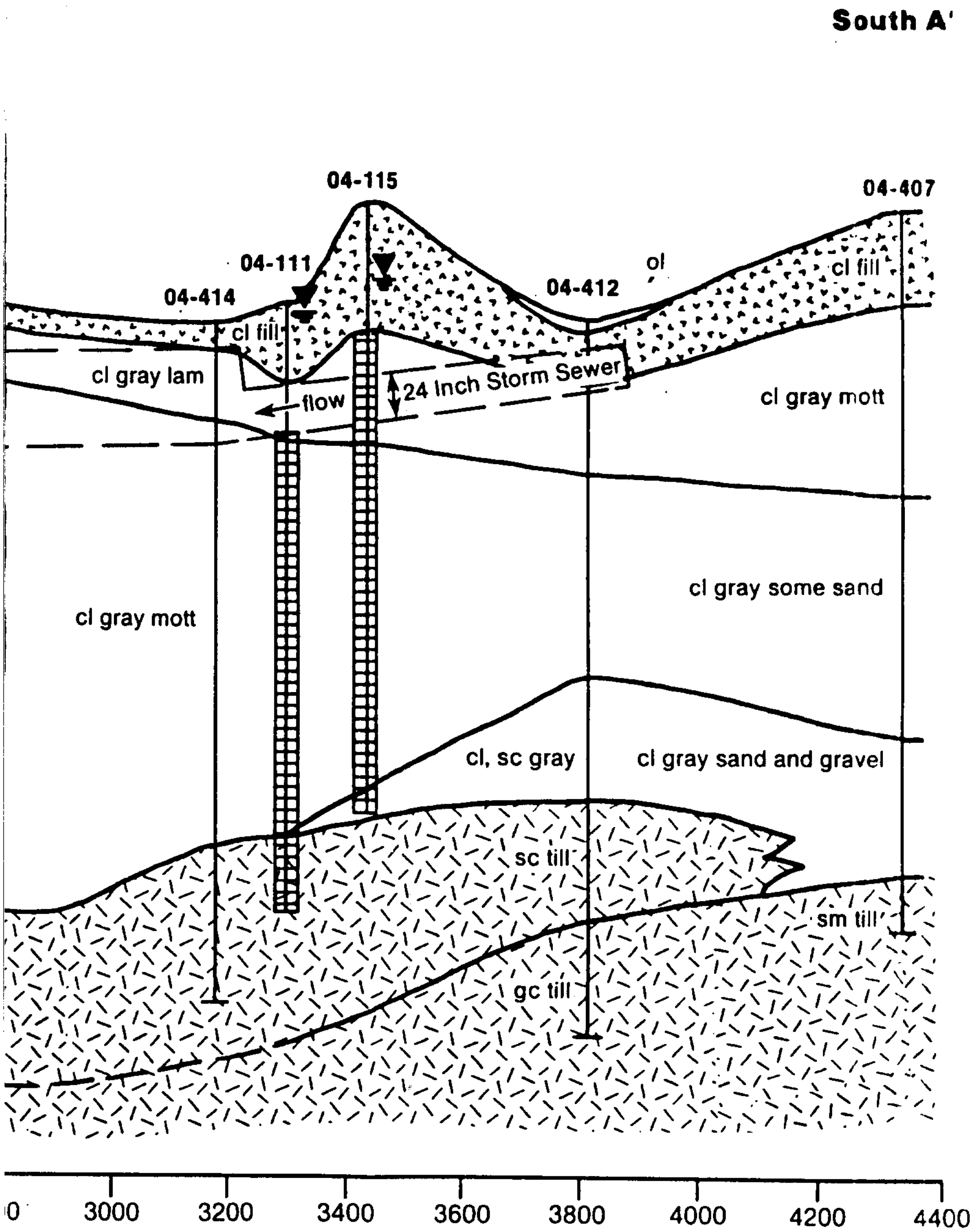
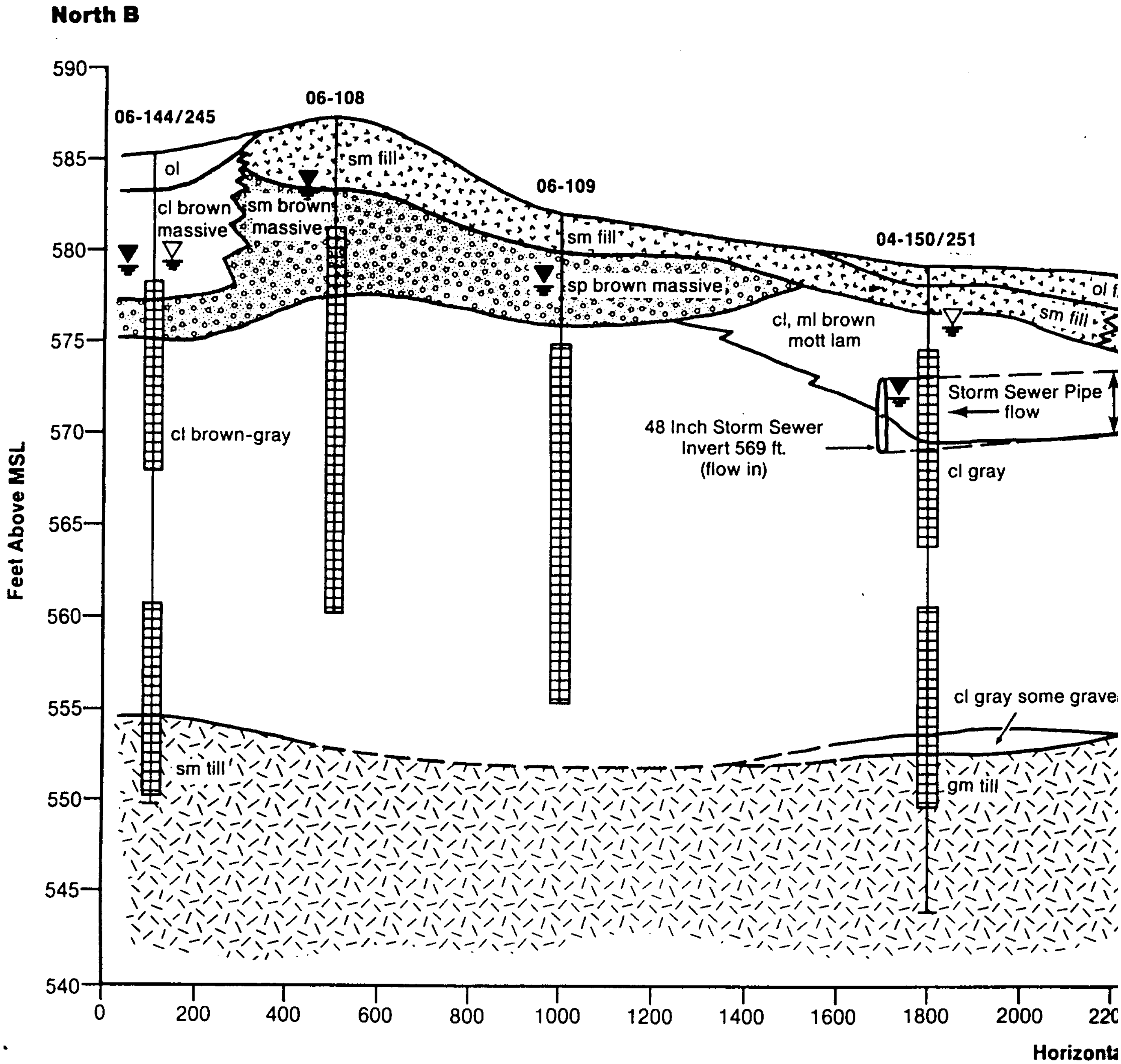


FIGURE 4-42 WRMP/NWLF GEOLOGIC CROSS SECTION A-A'


North B
06-144/245
06-108
06-109
04-150/251
ol
sm fill
cl brown massive
sm brown massive
sm fill
sp brown massive
cl, ml brown mott lam
ol f
sm fill
Storm Sewer Pipe
flow
48 Inch Storm Sewer Invert 569 ft. (flow in)
cl brown-gray
cl gray
cl gray some grave
sm till
gm till
Feet Above MSL
590
585
580
575
570
565
560
555
550
545
540
0
200
400
600
800
1000
1200
1400
1600
1800
2000
220
Horizonta

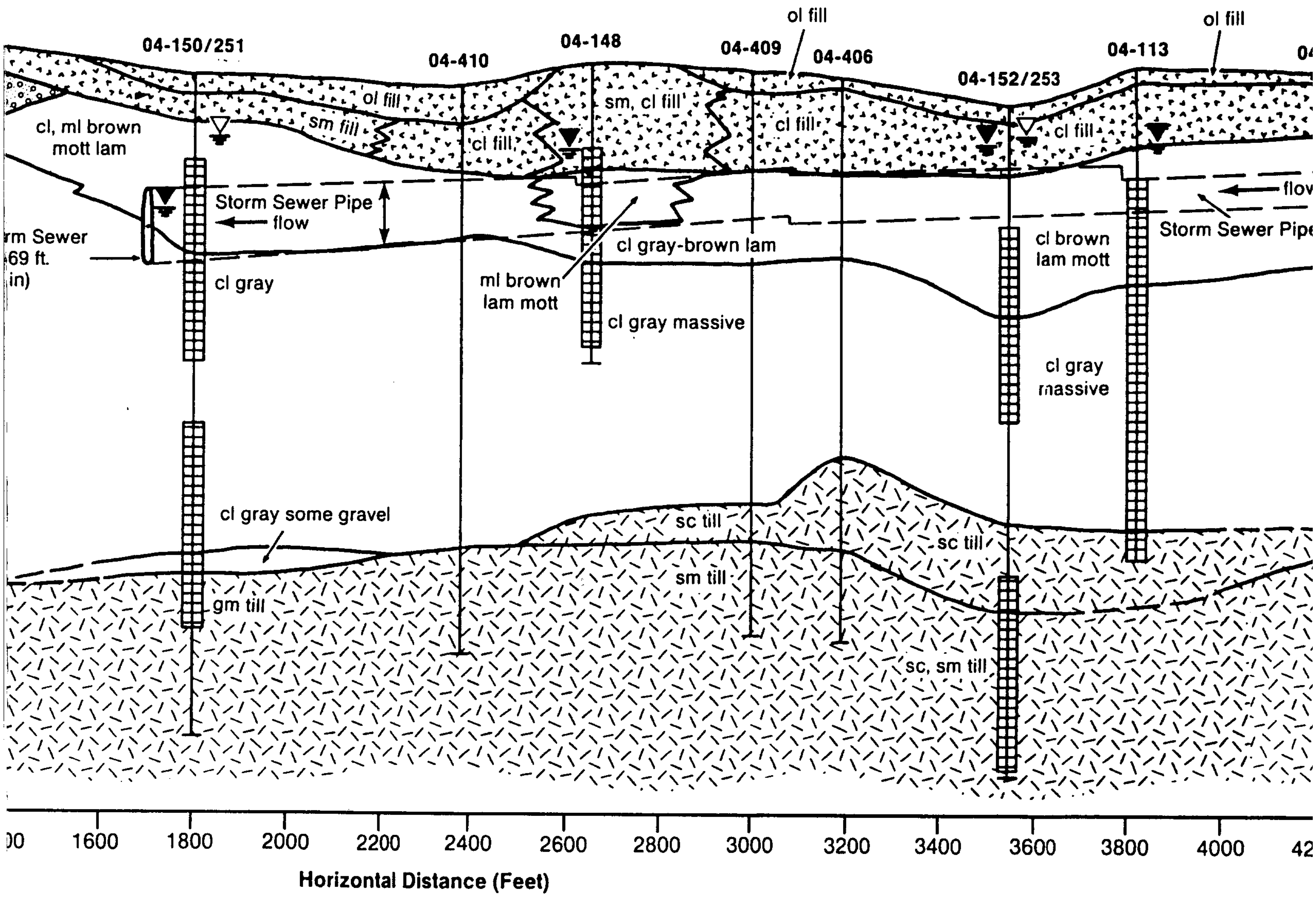

ol fill
04-150/251
04-410
04-148
04-409
04-406
04-152/253
04-113
ol fill
cl, ml brown
mott lam
ol fill
sm fill
cl fill
sm, cl fill
cl fill
cl fill
Storm Sewer Pipe
flow
flow
Storm Sewer Pipe
rm Sewer
69 ft.
in)
cl gray-brown lam
cl brown
lam mott
cl gray
ml brown
lam mott
cl gray massive
cl gray
massive
cl gray some gravel
sc till
sc till
sm till
gm till
sc, sm till
00
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
42
Horizontal Distance (Feet)

FIGURE 4-43

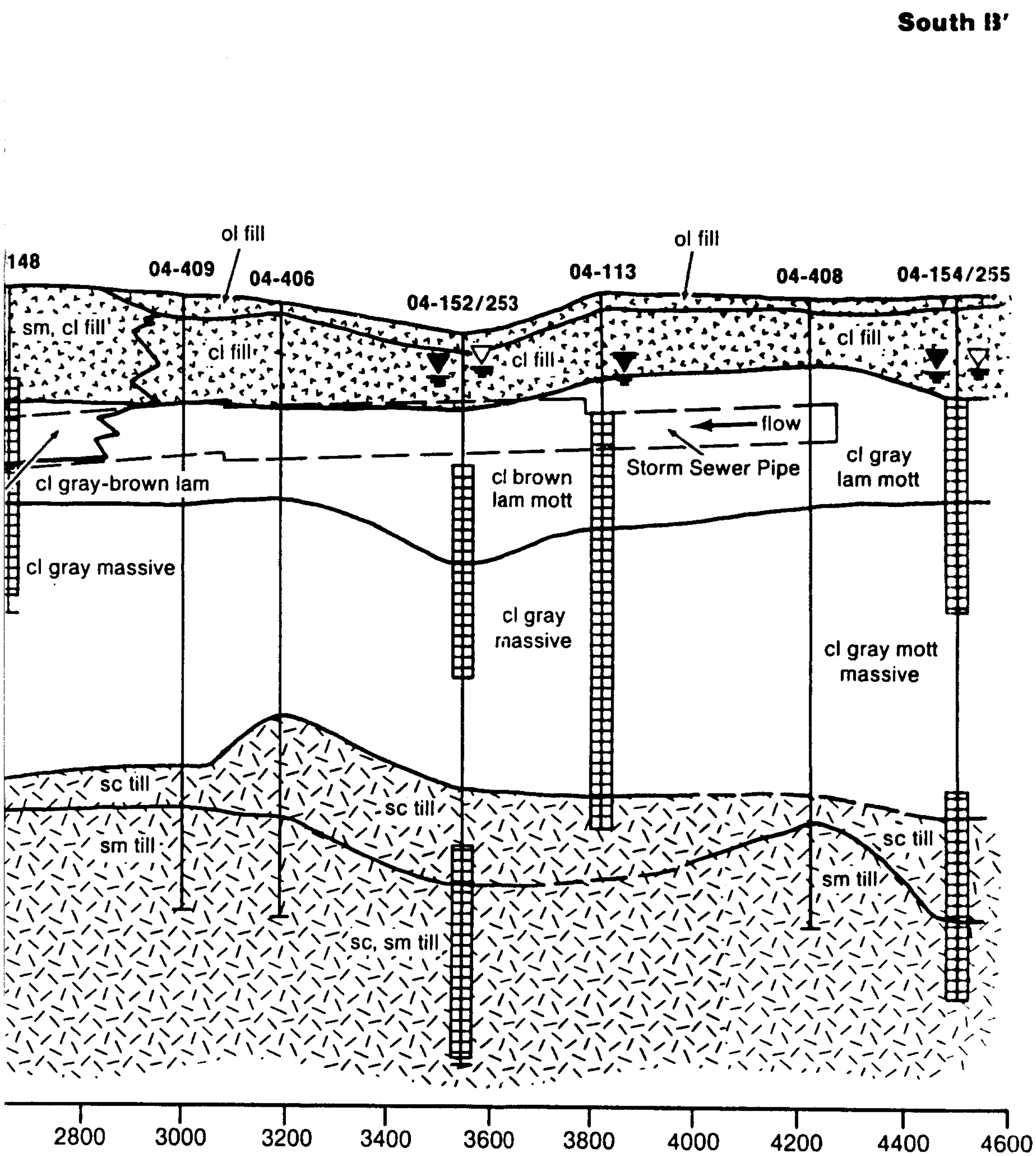


FIGURE 4-43 WRMP/NWLF GEOLOGIC CROSS SECTION B-B'

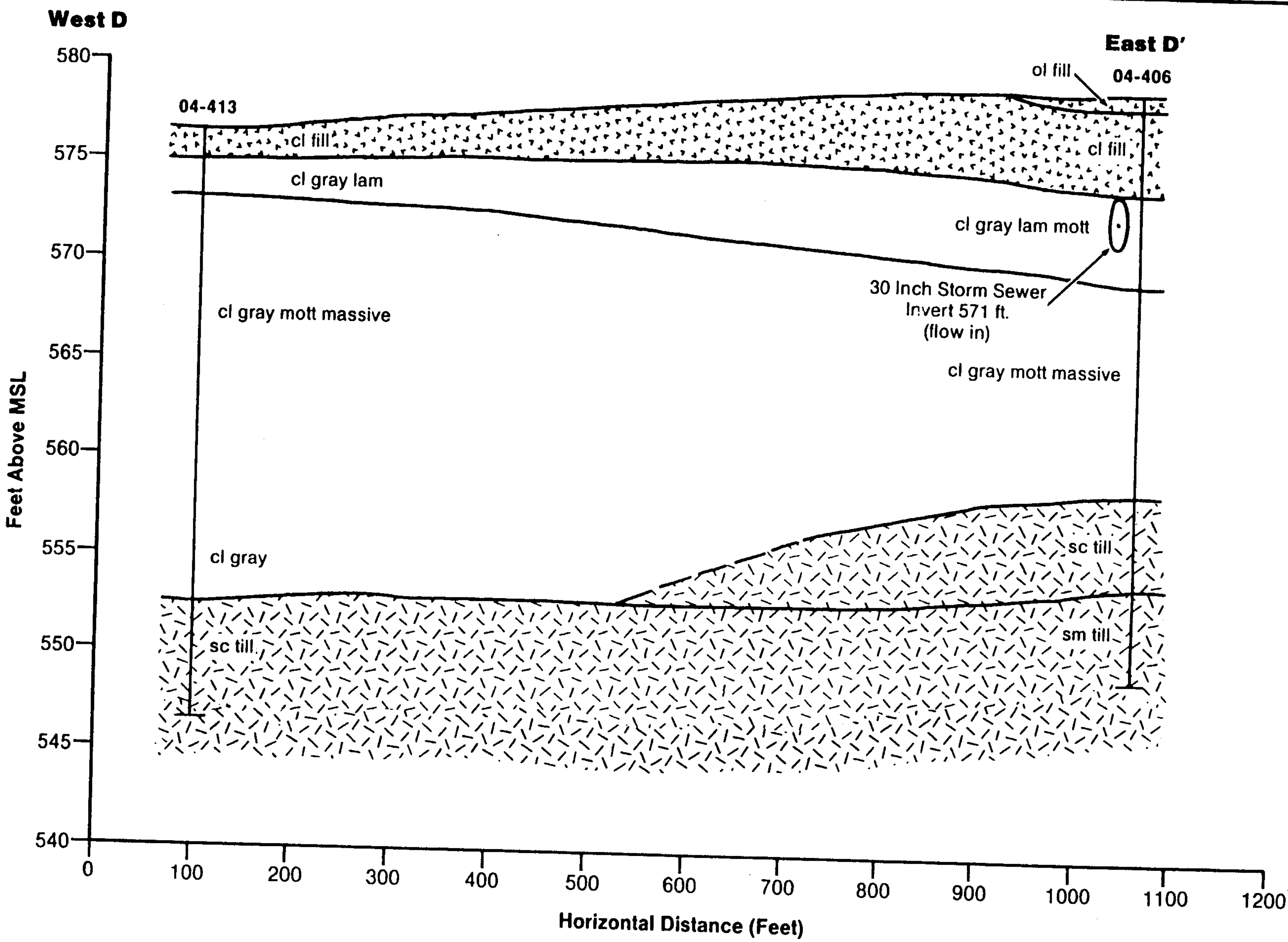
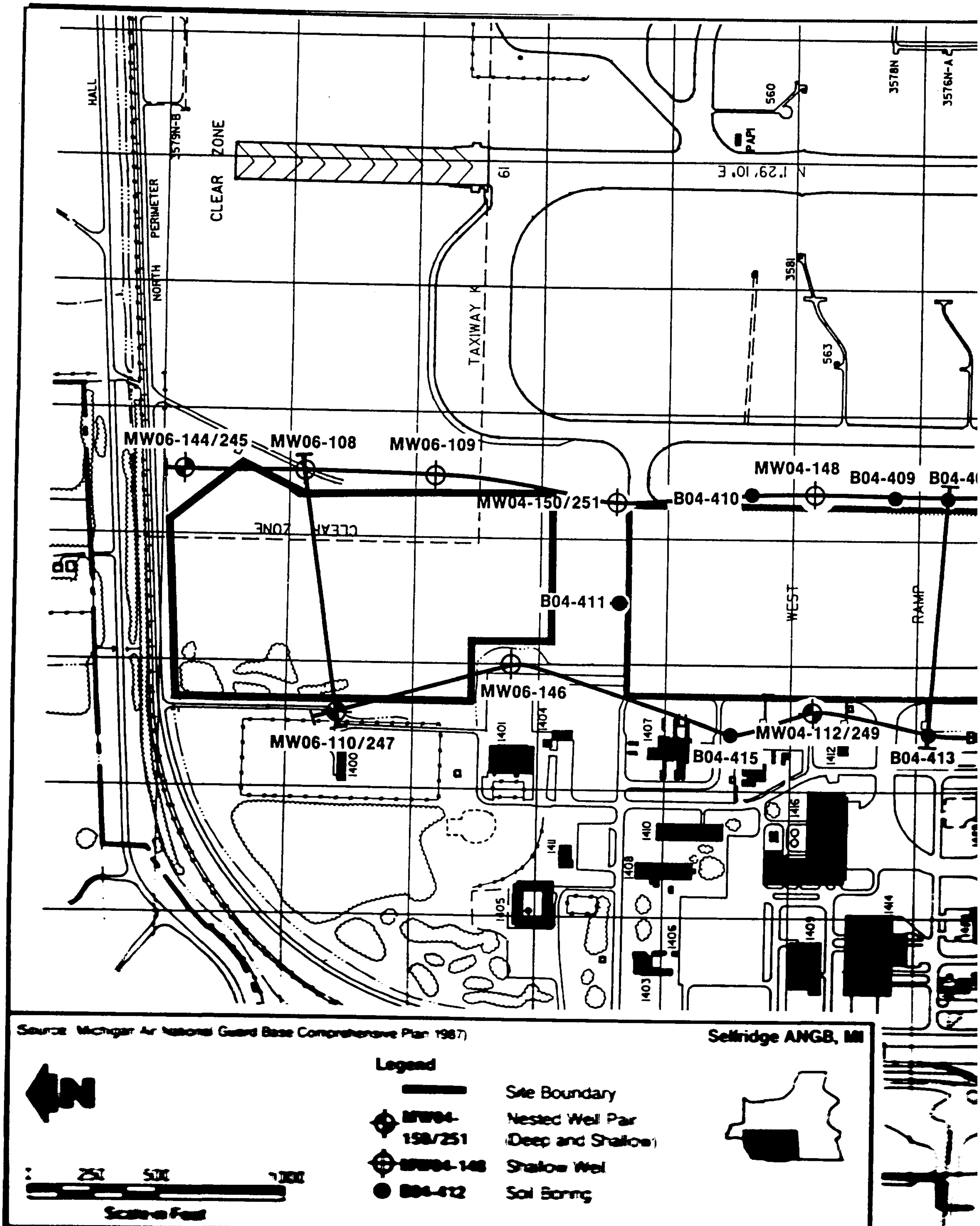


FIGURE 4-44 WRMP/NWLF GEOLOGIC CROSS SECTION D-D'


HALL
NORTH PERIMETER
3579N-B
CLEAR ZONE
TAXIWAY K
19
N 1°29'10" E
560
PAPI
3578N
3576N-A
3581
563
MW06-144/245
MW06-108
MW06-109
MW04-150/251
B04-410
MW04-148
B04-409
B04-411
CLEAR ZONE
WEST
RAMP
MW06-146
MW06-110/247
MW04-112/249
B04-415
B04-413
1400
1401
1404
1407
1412
1410
1416
1411
1408
1405
1406
1403
1409
1414
Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW04-150/251
Nested Well Pair (Deep and Shallow)
MW04-148
Shallow Well
B04-412
Soil Boring
0 250 500 1000
Scale in Feet
N

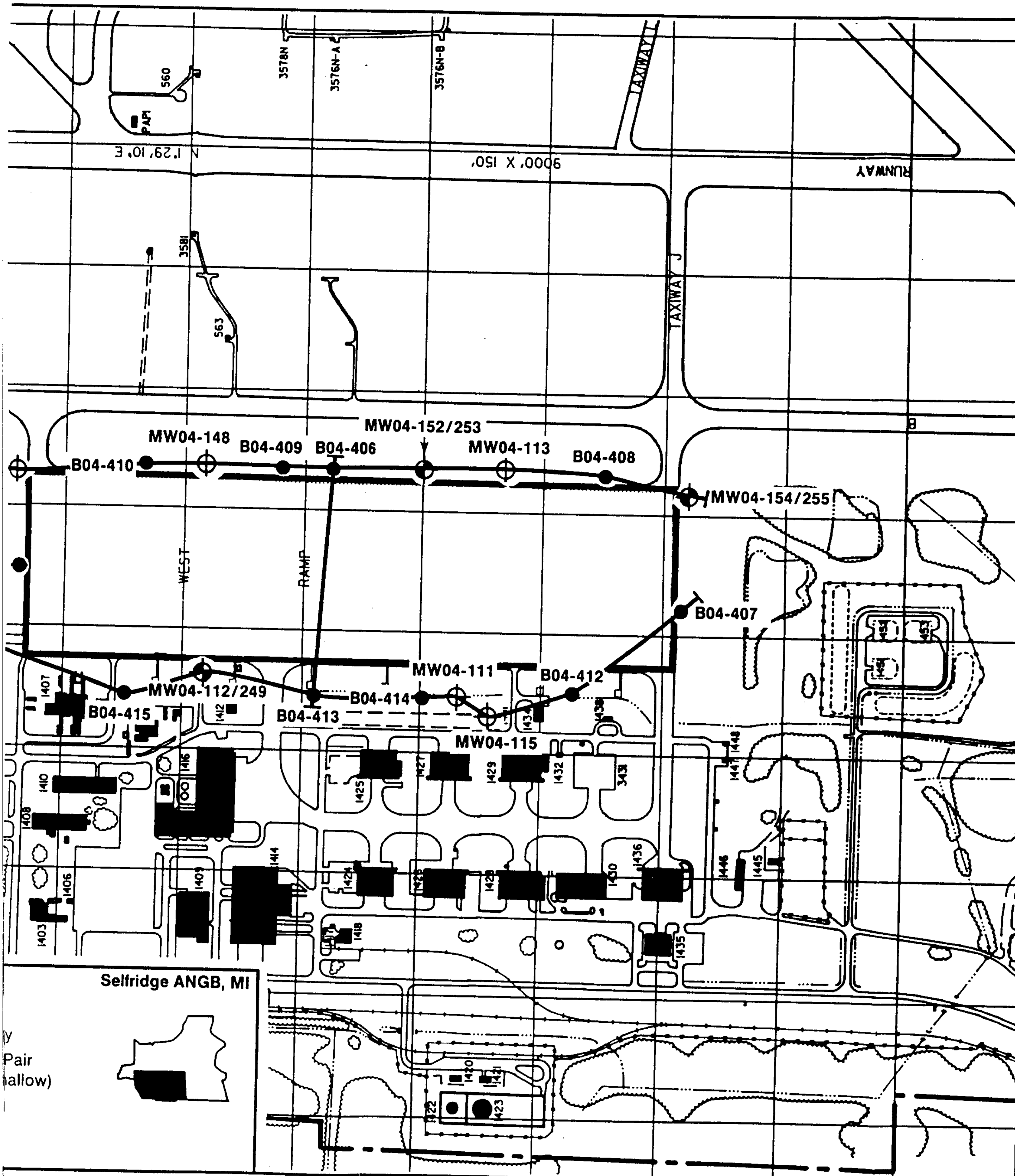

RUNWAY
9000' X 150'
TAXIWAY J
TAXIWAY J
WEST
RAMP
MW04-148
B04-409
B04-406
MW04-152/253
MW04-113
B04-408
B04-410
MW04-154/255
B04-407
MW04-111
B04-412
MW04-112/249
B04-415
B04-413
B04-414
MW04-115
Selfridge ANGB, MI
y
Pair
hallow)

FIGURE 4

WESTON

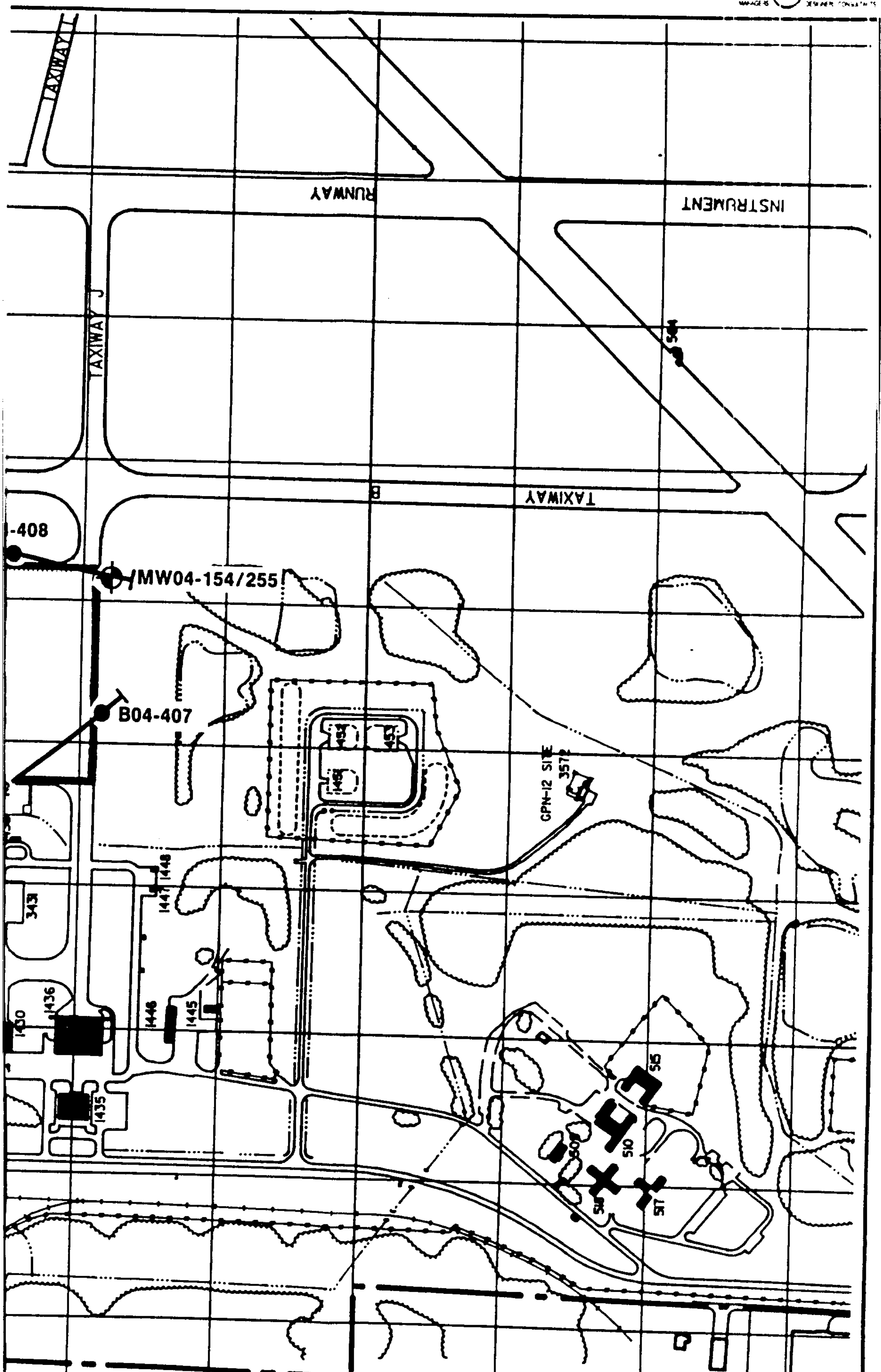


FIGURE 4-45 TRACE OF CROSS SECTIONS A-A′, B-B′, C-C′, AND D-D′ AT WRMP/NWLF

units or more. The sample intervals in soil borings displaying the maximum OVA readings were the 25- to 30-foot core in boring 04-409 (800 to <1,000 units); the 28- to 30-foot core in 04-411 (600 to 800 units); and the 20- to 25-foot core in boring 04-406 (1,000 units). The readings were believed to be detections of methane, based upon the responses of the two types of field instruments -- an HNu (PID) and an OVA (FID).

A brown, oil-like film was noted on the continuous sampler after it was removed from the 04-412 soil borehole at the 25- to 30-foot interval. The following day, a film of brown-colored oil was observed on the surface of the water that had collected in the soil boring overnight.

Most soil samples from groundwater monitor well borings at WRMP yielded OVA readings at background. Four groundwater monitor well borings at WRMP (04-154, 04-249, 04-253, and 04-255) yielded soil samples that registered OVA readings above the background level. The maximum readings were measured in samples from monitor well borings 04-249 and 04-225; the 25- to 27-foot interval in boring 04-249 registered 10 to 1,000 units, while the 25- to 30-foot interval in boring 04-255 registered 800 to 900 units. Other elevated readings included 30 to 700 units in the 10- to 15-foot interval from boring 04-154 and 200 units registered in the 30- to 35-foot interval from monitor well boring 04-253. There was no visible evidence of potential subsurface contamination observed while drilling groundwater monitor well borings.

4.7.1.2 Extent and Character of Unsaturated Zone -- WRMP

The thickness of the unsaturated zone, as observed in soil and monitor well borings, varies around the perimeter of the WRMP. Unsaturated conditions occurred to a depth between 5 and 7 feet BLS along the western perimeter of the site. Along the eastern and northern perimeters the unsaturated zone extends to a depth between 9 and 11 feet BLS. The maximum thickness of the unsaturated zone was 12 feet. This was observed in soil boring 04-407 at the southern end of the site.

Fill material comprises the upper portion of the unsaturated zone at WRMP, as seen in Figures 4-42, 4-43, and 4-44. Placement of the fill, which serves as a foundation for the concrete ramp, occurred prior to construction of the WRMP. Based upon boring information, the fill material consists of a mixture of silt, clay, and sand ranging in thickness from 1 to 11 feet. A topsoil layer has developed on top of the fill and is approximately 1 to 1.5 feet in thickness.

The lower portion of the unsaturated zone consists of natural clayey silt to silty clay, varying from brown to gray. This represents the upper portion of the lacustrine unit at WRMP. Iron-stained and orange-brown mottling was observed on boring

samples of the natural material. Light and dark gray laminations were observed throughout the lacustrine sequence.

Located near the base of the unsaturated zone are pipes from the stormwater drainage system. The locations of these drainage pipes are shown in Figures 4-42 and 4-43.

4.7.1.3 Groundwater Conditions -- WRMP

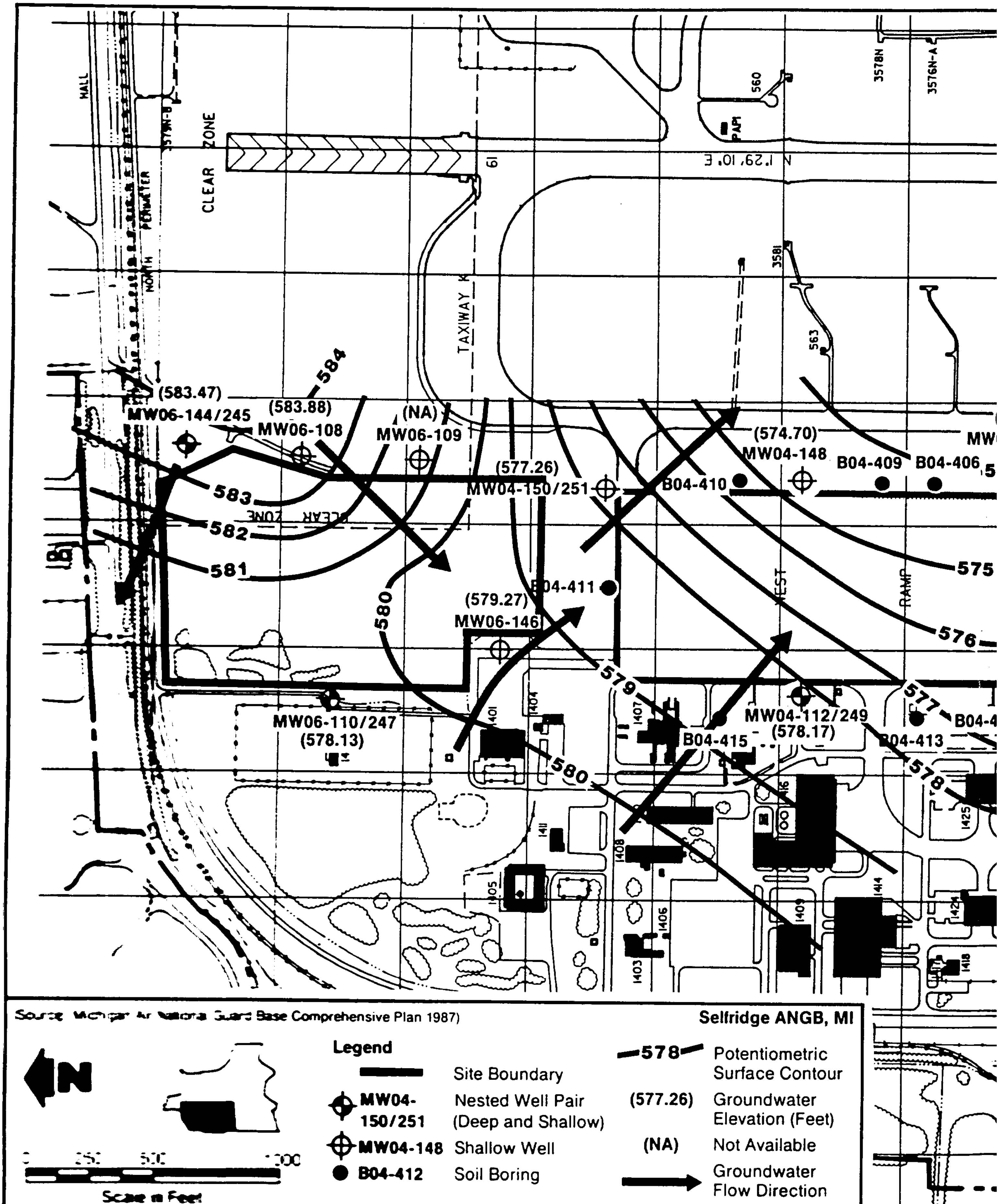
Determination of the top of the saturated zone was based upon observations made from soil and monitor well borings. The saturated zone was in part determined by the change from orange-brown mottling to gray mottling. The boundary was also recognized by the relative water content of the lacustrine unit.

The saturated zone consists predominantly of the lacustrine unit and the upper part of the till units. Saturated conditions were encountered between 5 and 12 feet BLS within the lacustrine unit and continued through the upper till unit. Very little free moisture was noted in samples from the lower part of the till unit.

The shallow monitor wells at WRMP were installed at depths ranging between 14.0 and 17.2 feet. Their 10-foot screens were positioned within the brown laminated clay and gray clay intervals. The shallow monitor wells installed during Phase II Stage 1 were installed primarily in the brown laminated clay and gray clay intervals. Portions (1 to 2 feet) of the 20-foot screens in wells 04-111, 04-112, and 04-113 were installed in the sandy till as well as in the brown and gray clay. The deep monitor wells at WRMP were installed at depths ranging between 28.0 and 35.0 feet. These monitor wells have 10-foot screens. Monitor well 04-253 was screened entirely in the sandy till. Monitor wells 04-249, 04-251, and 04-255 were screened in both the gray lacustrine clay and sandy till intervals.

Seven water level measurement rounds were taken at WRMP between 1 February and 1 August 1988. During March 1988 water level measurements were not taken in monitor wells 04-111 and 04-113. High water levels in the monitor wells and freezing temperatures resulted in the formation of ice inside the monitor well, preventing measurement of the water level. Monitor wells 04-150, 04-249, and 04-251 were not installed at WRMP until after water level measurements on 1 February 1988.

A potentiometric surface map of shallow monitor wells at WRMP and NWLF for the period 21 March 1988 is shown in Figure 4-46. Water level measurements in monitor wells prior to March 1988 were not used to construct potentiometric maps because equilibrium conditions had not been established. Water level data from monitor wells at NWLF were used to provide additional elevation definition at the northern end of WRMP. Groundwater flow, as defined by this potentiometric surface map, is



HALL
3579N-B
NORTH PERIMETER
CLEAR ZONE
61
TAXIWAY K
560
PAPI
3578N
3576N-A
N 1°29'10" E
3581
563
584
583
582
581
580
579
578
577
576
575
(583.47)
MW06-144/245
(583.88)
MW06-108
(NA)
MW06-109
(577.26)
MW04-150/251
(574.70)
MW04-148
B04-410
B04-409
B04-406
B04-411
(579.27)
MW06-146
MW06-110/247
(578.13)
B04-415
MW04-112/249
(578.17)
B04-413
WEST RAMP
401
404
1407
1411
1405
1408
1406
1403
1409
1414
1424
1425
1418
Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0 250 500 1000
Scale in Feet
Legend
Site Boundary
MW04-150/251 Nested Well Pair (Deep and Shallow)
MW04-148 Shallow Well
B04-412 Soil Boring
578 Potentiometric Surface Contour
(577.26) Groundwater Elevation (Feet)
(NA) Not Available
Groundwater Flow Direction

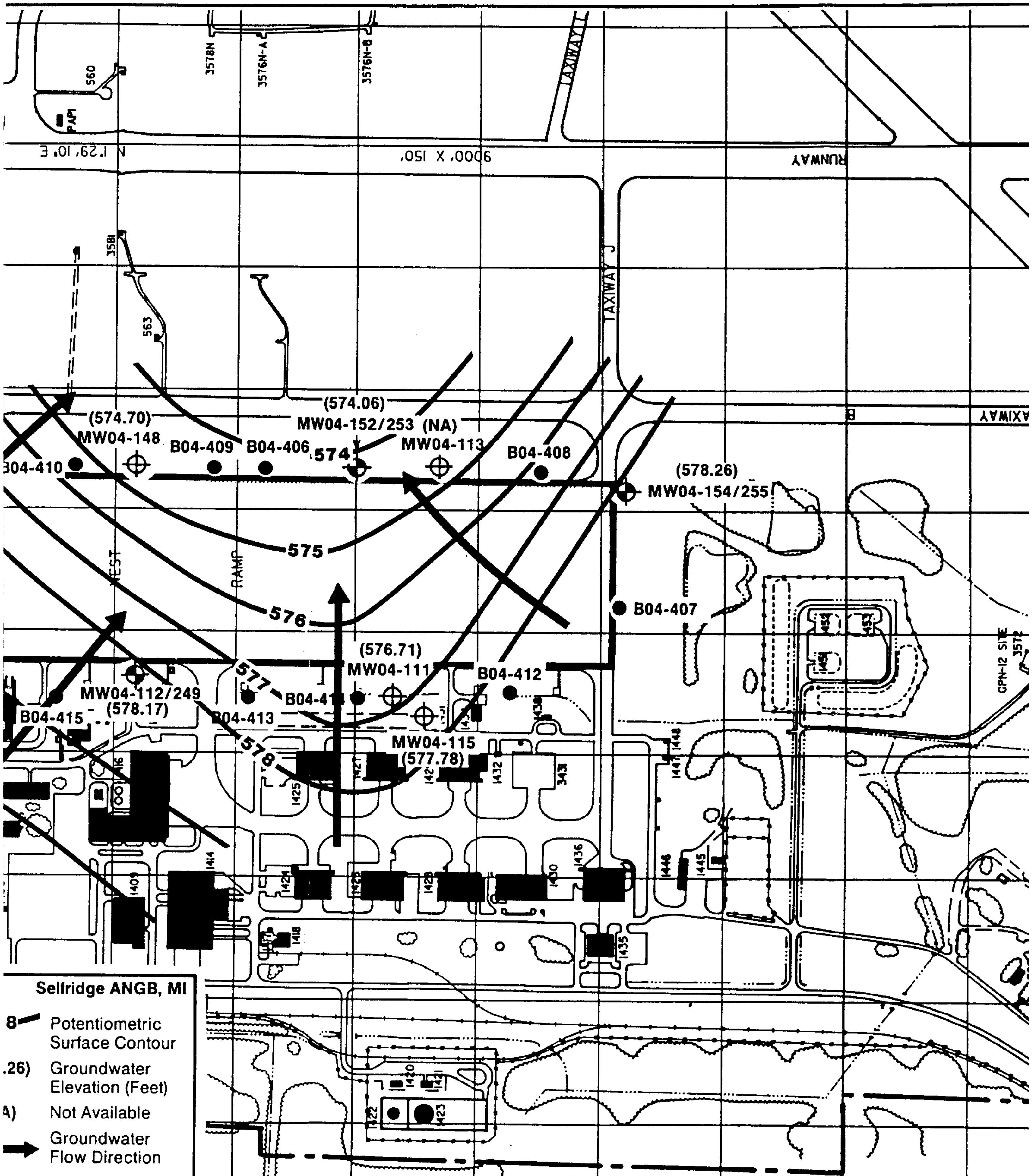


FIGURE 4-46 WRMP/NW
POTENTIO
MAP FOR S
ON 21 MAR

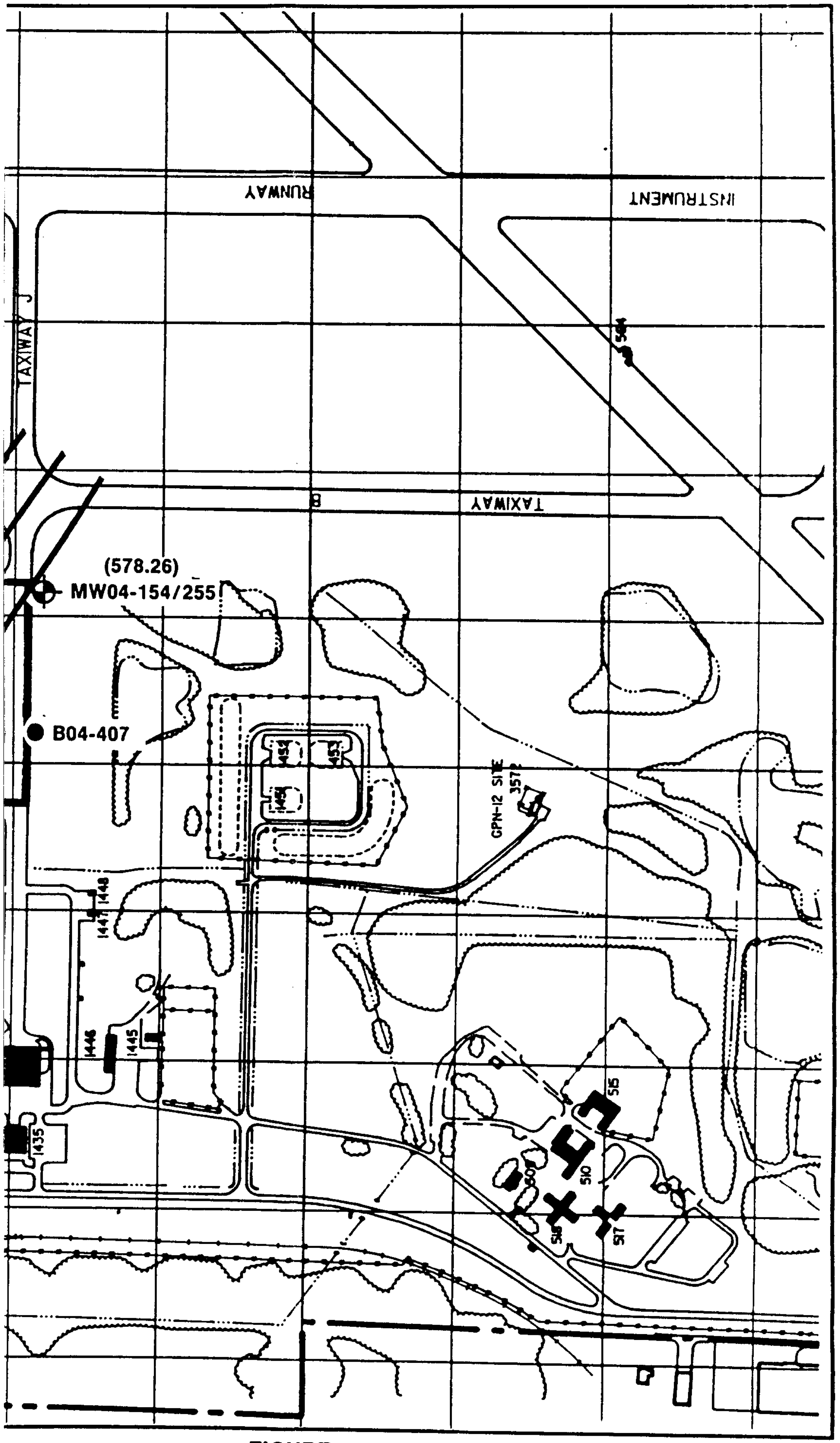


FIGURE 4-46 WRMP/NWLF POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 21 MARCH 1988

generally toward the east. A trough exists in the potentiometric surface along a line between monitor wells 04-111 and 04-152. This trough causes groundwater from the northern end of the site to flow in a southeasterly direction and groundwater from the southern portion of the site to flow to the northeast toward monitor well 04-152. The WRMP area appears to have a local groundwater sink, produced by the infiltration of groundwater to the stormwater drainage network. Figure 3-17 shows the location of the drainage network around the WRMP.

Figure 4-47 shows the potentiometric surface map for deep monitor wells at WRMP and NWLF on 21 March 1988. Groundwater flow, based upon this map, is toward the east.

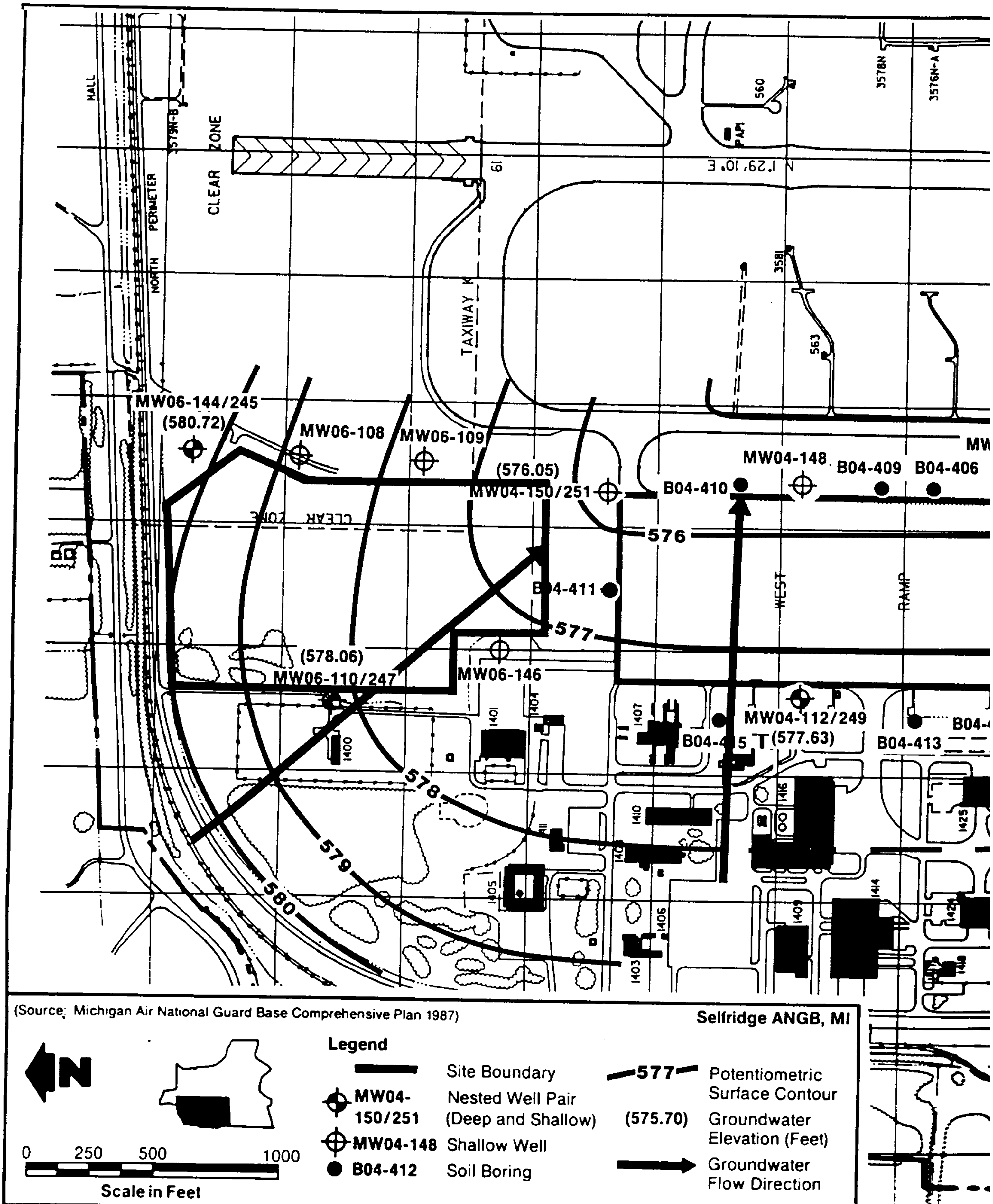
Groundwater flow was to the east for shallow monitor wells on 1 August 1988. Figure 4-48 is the potentiometric surface map for this period. A trough no longer exists in the potentiometric surface map between monitor wells 04-111 and 04-152. The groundwater flow appears to converge on an area near monitor well 04-150, as seen in Figure 4-48. Water level measurements in monitor wells between April and July 1988 were not used to construct potentiometric maps because equilibrium conditions did not exist because of sampling activities.

The deep monitor well potentiometric surface map at WRMP and NWLF for 1 August 1988 is presented in Figure 4-49. Little change has occurred in the deep monitor well potentiometric surface since 21 March 1988. Groundwater flow is still to the east.

Horizontal gradients of 0.003 ft/ft and 0.0004 ft/ft were calculated from the 21 March and 1 August 1988 shallow potentiometric maps. A horizontal gradient of 0.0014 ft/ft was calculated for both 21 March and 1 August 1988 deep potentiometric maps.

Hydraulic conductivities (K) were determined for all monitor wells at WRMP using baildown/recovery tests. The K values determined for each monitor well are presented in Table 3-18. The average K value, based upon all monitor wells at WRMP, was 9.2 x 10^{-7} ft/sec (2.8 x 10^{-5} cm/sec). For WRMP shallow monitor wells the average K value was 1.14 x 10^{-6} ft/sec (3.5 x 10^{-5} cm/sec). The average K value for the deep monitor wells (04-249, 04-251, 04-253, and 04-255) was 4.64 x 10^{-7} ft/sec (1.42 x 10^{-5} cm/sec). These average K values were used to calculate groundwater flow velocities.

Using the shallow groundwater gradient (i) for 21 March 1988, the average shallow monitor well hydraulic conductivity (K), and an effective porosity (n) value for the material into which the monitor well is screened, a groundwater flow velocity (V) was calculated using the equation $V = Ki/n$. An effective porosity value of 15 percent was used to make the calculations.



MW06-144/245
(580.72)
MW06-108
MW06-109
(576.05)
MW04-150/251
MW04-148
B04-409
B04-406
B04-410
B04-411
576
577
578
579
580
(578.06)
MW06-110/247
MW06-146
MW04-112/249
(577.63)
B04-413
CLEAR ZONE
TAXIWAY K
NORTH PERIMETER
HALL
WEST RAMP
PAPI
1400
1401
1404
1407
1410
1416
1425
1405
1406
1403
1409
1414
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW04-150/251 Nested Well Pair (Deep and Shallow)
MW04-148 Shallow Well
B04-412 Soil Boring
577 Potentiometric Surface Contour
(575.70) Groundwater Elevation (Feet)
Groundwater Flow Direction
0 250 500 1000
Scale in Feet
N

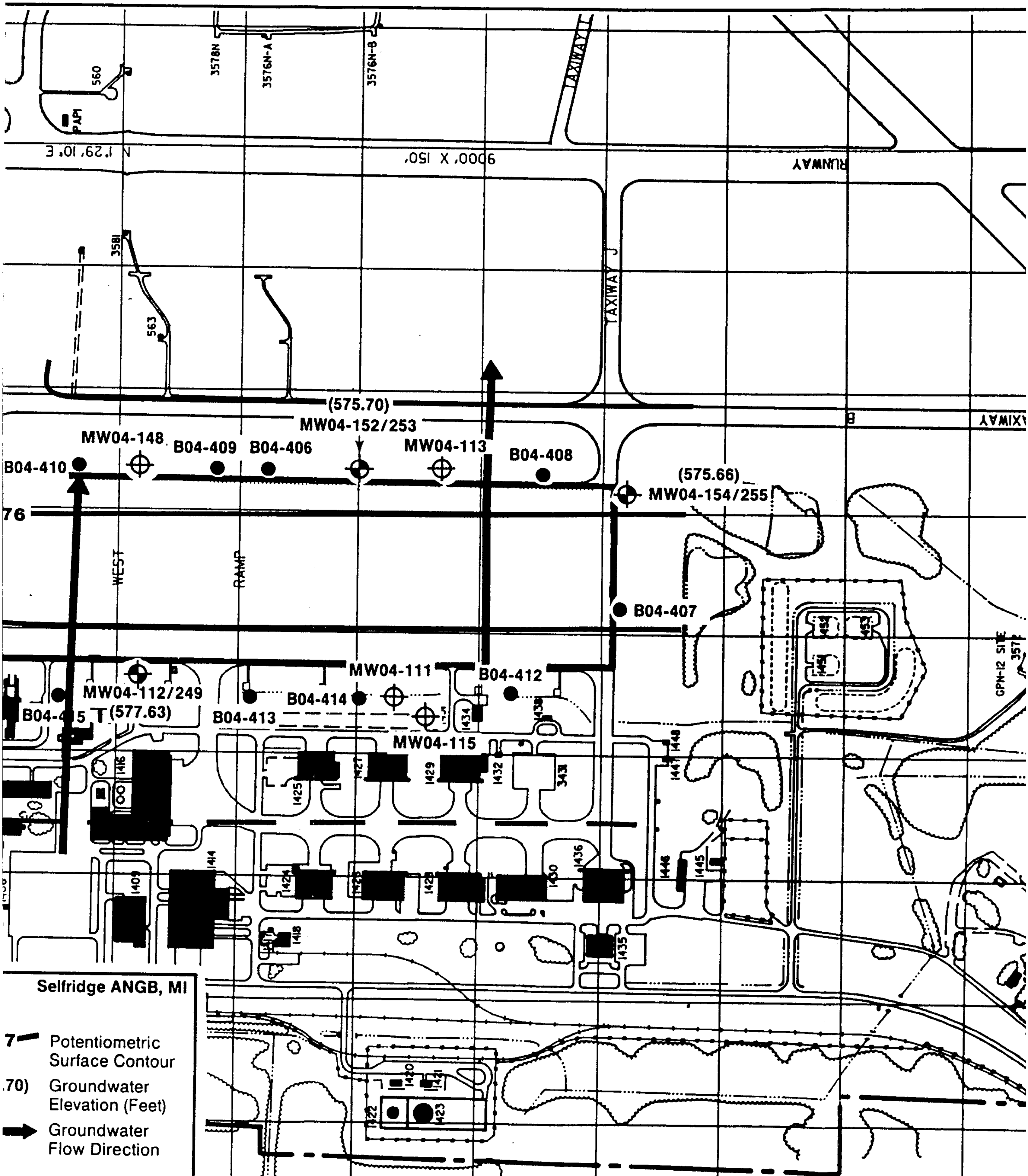


FIGURE 4-47 WRM
POTE
MAP
ON 21

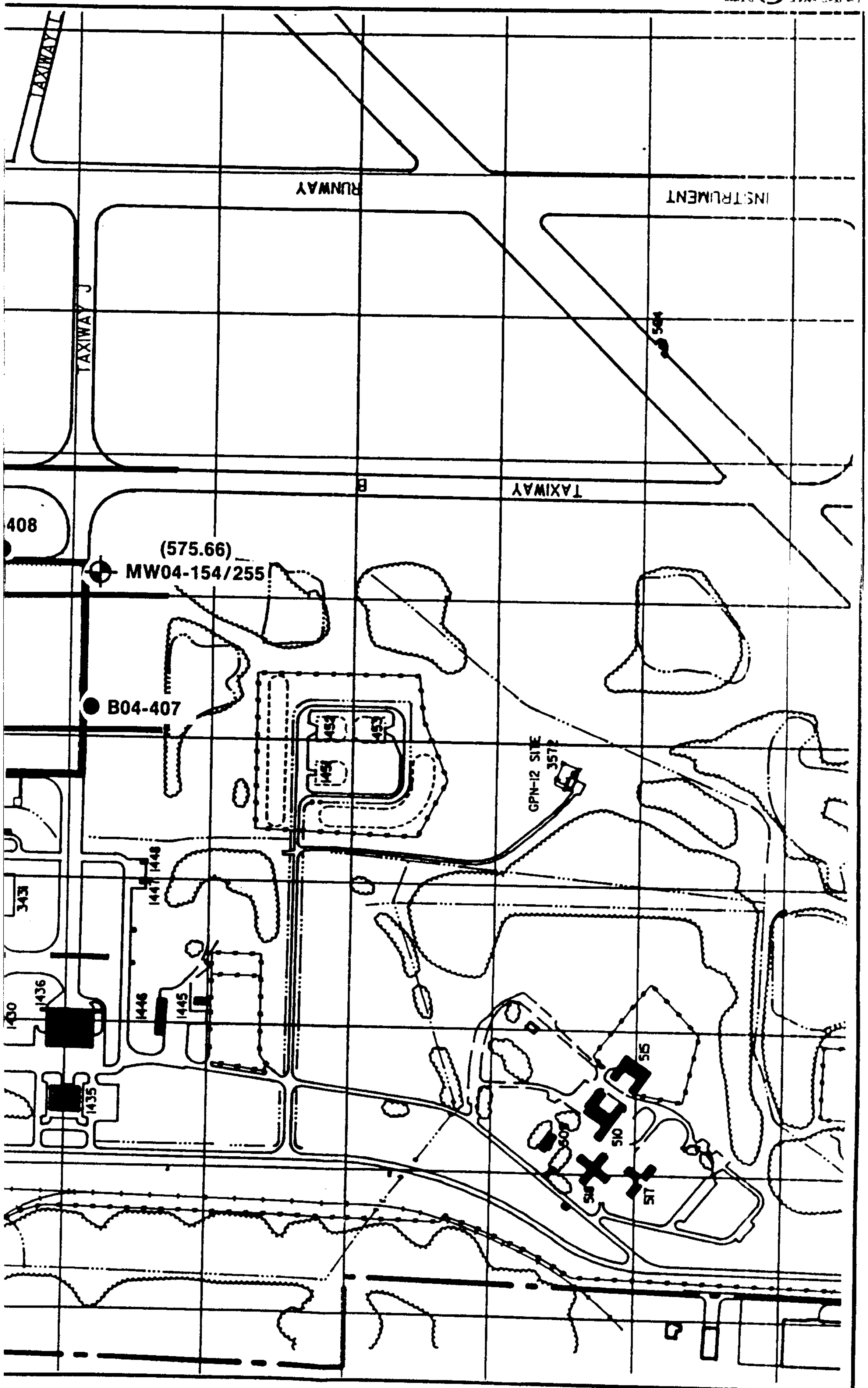
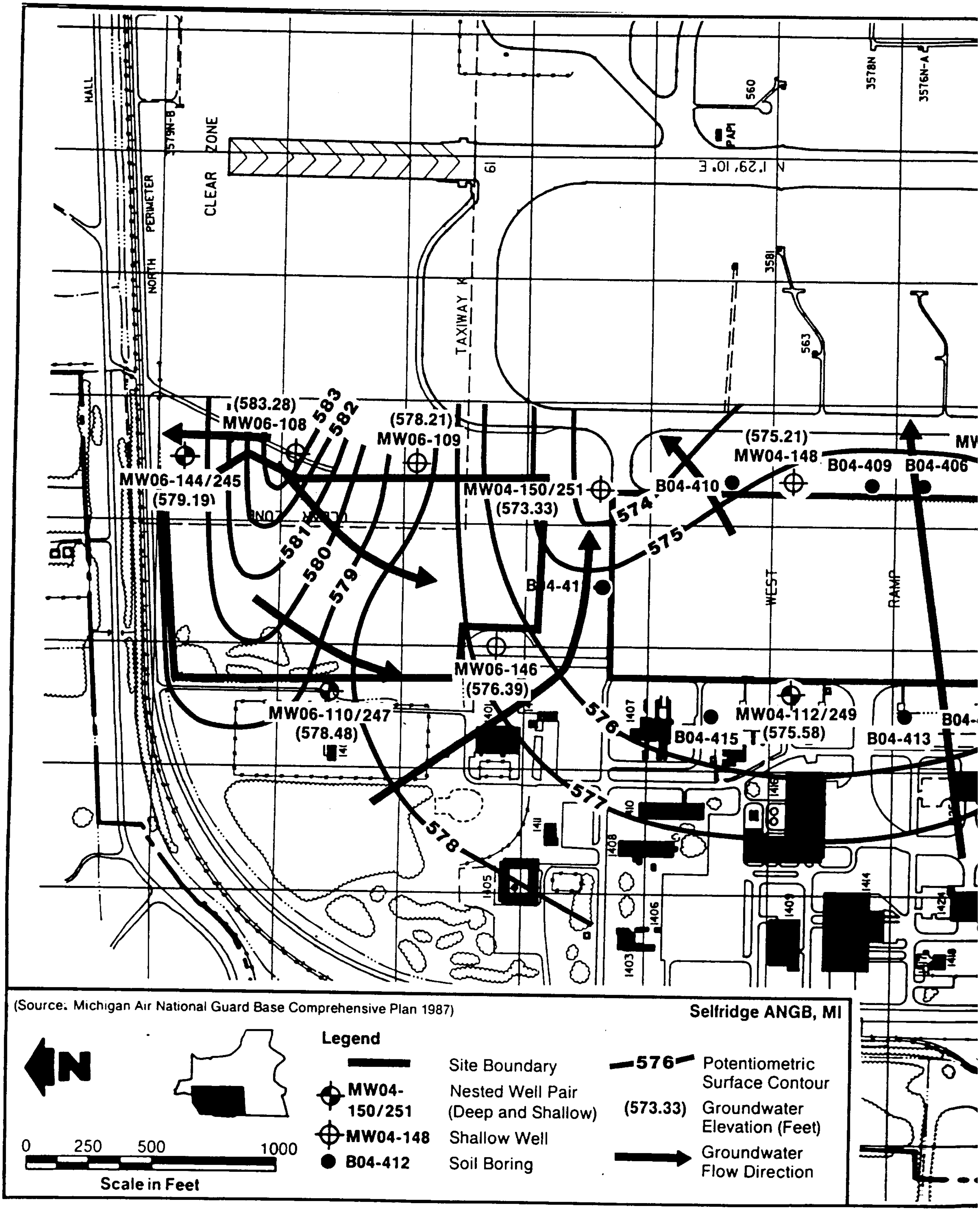
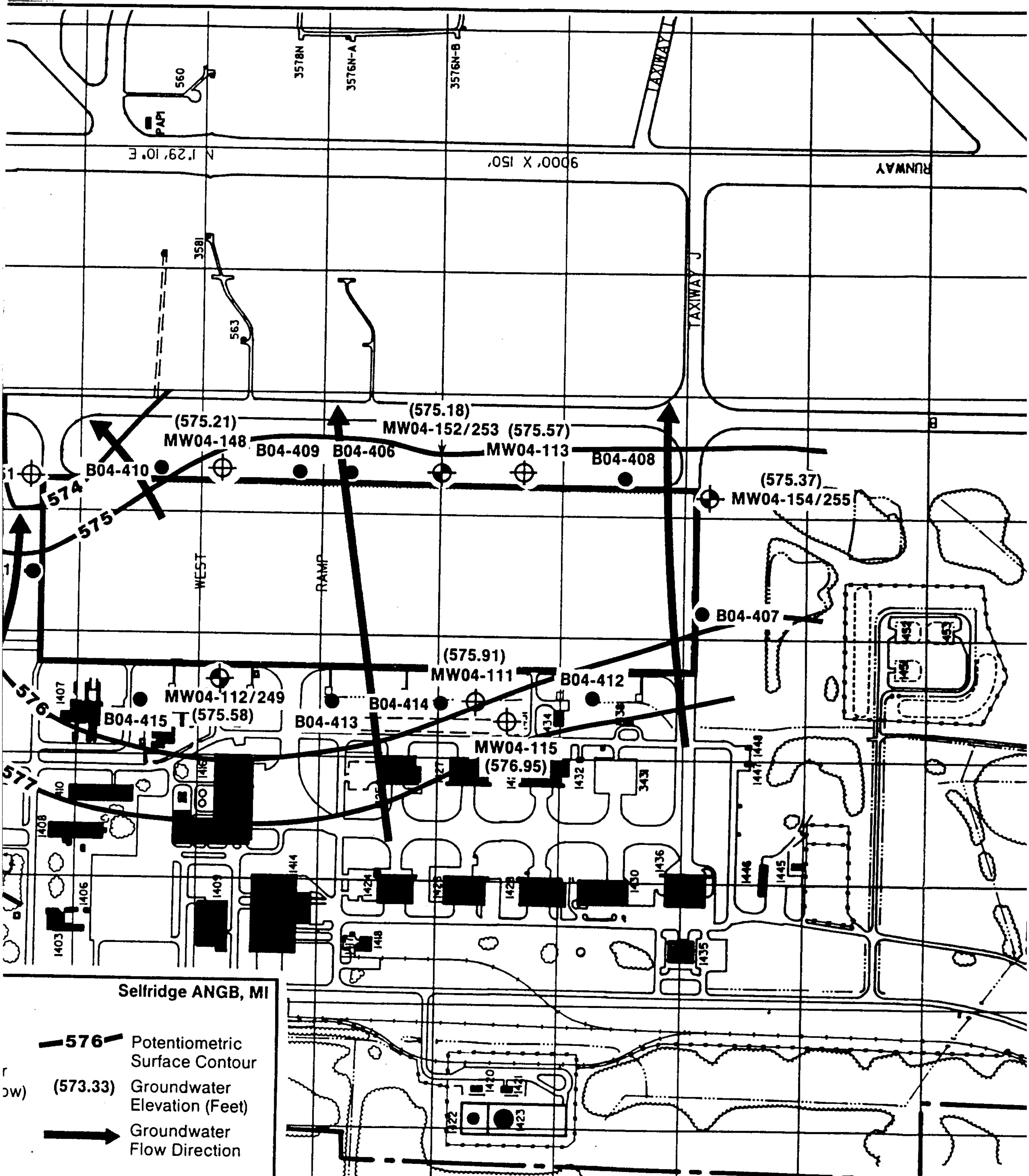


FIGURE 4-47 WRMP/NWLF POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 21 MARCH 1988



HALL
NORTH PERIMETER
3579N-B
CLEAR ZONE
TAXIWAY K
61
N 1.29,10.E
560
PAPI
3578N
3576N-A
3581
563
WEST
RAMP
583
582
581
580
579
578
577
576
575
574
(583.28)
MW06-108
(578.21)
MW06-109
MW06-144/245
(579.19)
MW04-150/251
(573.33)
(575.21)
MW04-148
B04-410
B04-409
B04-406
MW
B04-41
MW06-146
(576.39)
MW06-110/247
(578.48)
MW04-112/249
(575.58)
B04-415
B04-413
1401
1407
1410
1411
1408
1405
1406
1403
1409
1414
1424
1418
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
Legend
Site Boundary
MW04-150/251
Nested Well Pair (Deep and Shallow)
MW04-148
Shallow Well
B04-412
Soil Boring
576
Potentiometric Surface Contour
(573.33)
Groundwater Elevation (Feet)
Groundwater Flow Direction
0
250
500
1000
Scale in Feet



Selfridge ANGB, MI
576 Potentiometric Surface Contour
(573.33) Groundwater Elevation (Feet)
Groundwater Flow Direction
(575.21)
MW04-148
(575.18)
MW04-152/253
(575.57)
MW04-113
B04-410
B04-409
B04-406
B04-408
(575.37)
MW04-154/255
B04-407
(575.91)
MW04-111
B04-412
MW04-112/249
(575.58)
B04-415
B04-413
B04-414
MW04-115
(576.95)
574
575
576
577
WEST
RAMP
TAXIWAY J
9000' X 150'
RUNWAY

FIGURE 4-48

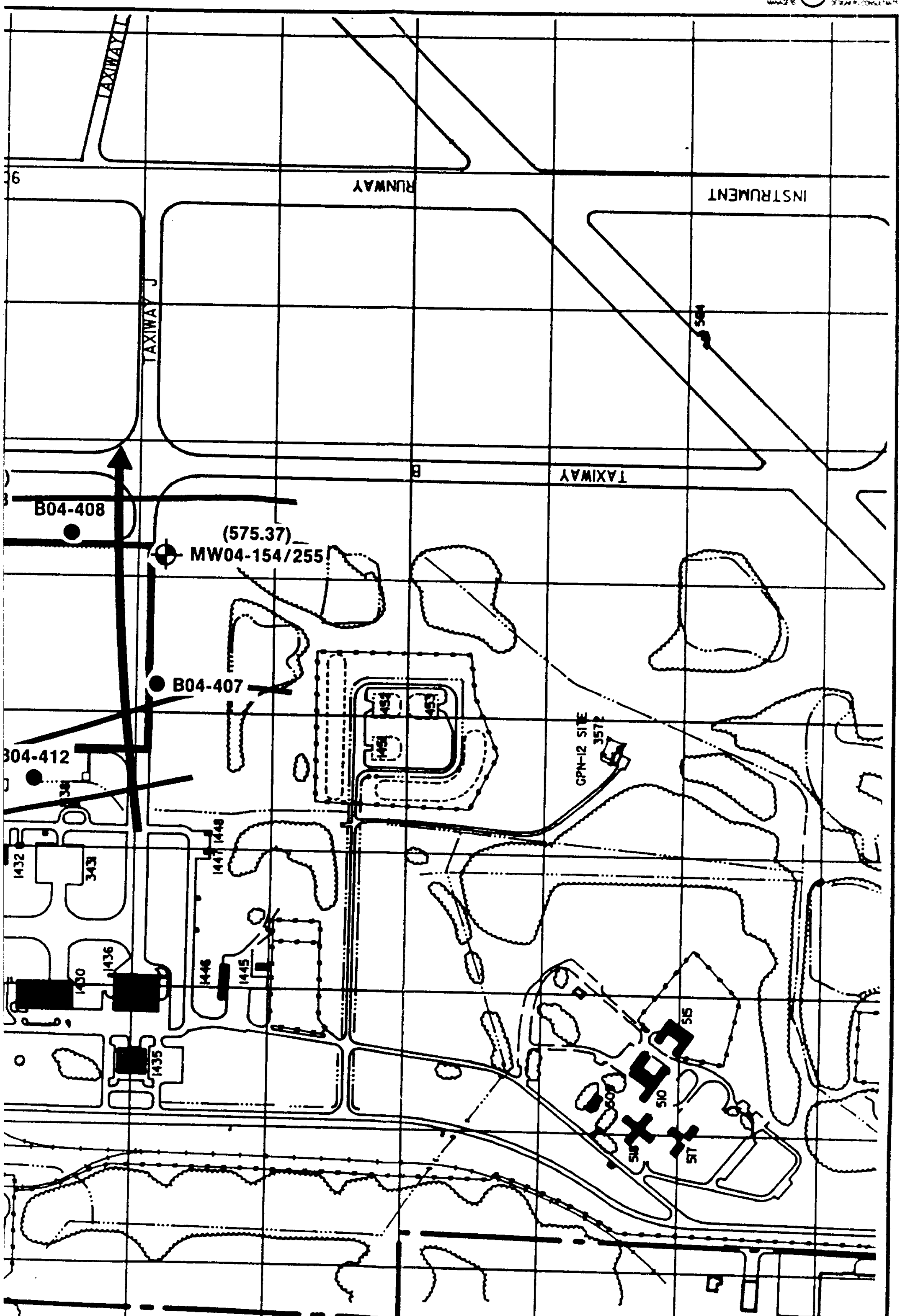
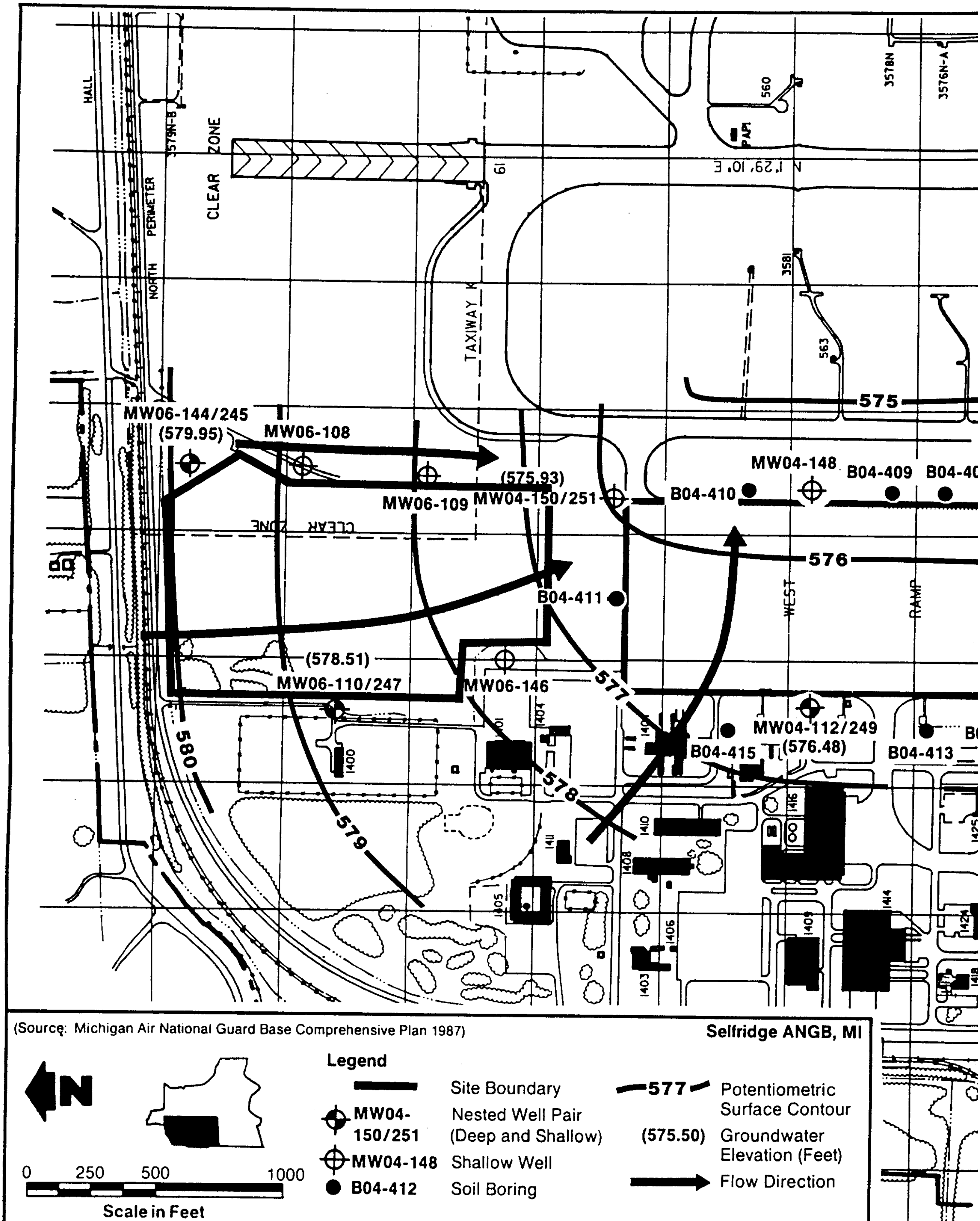
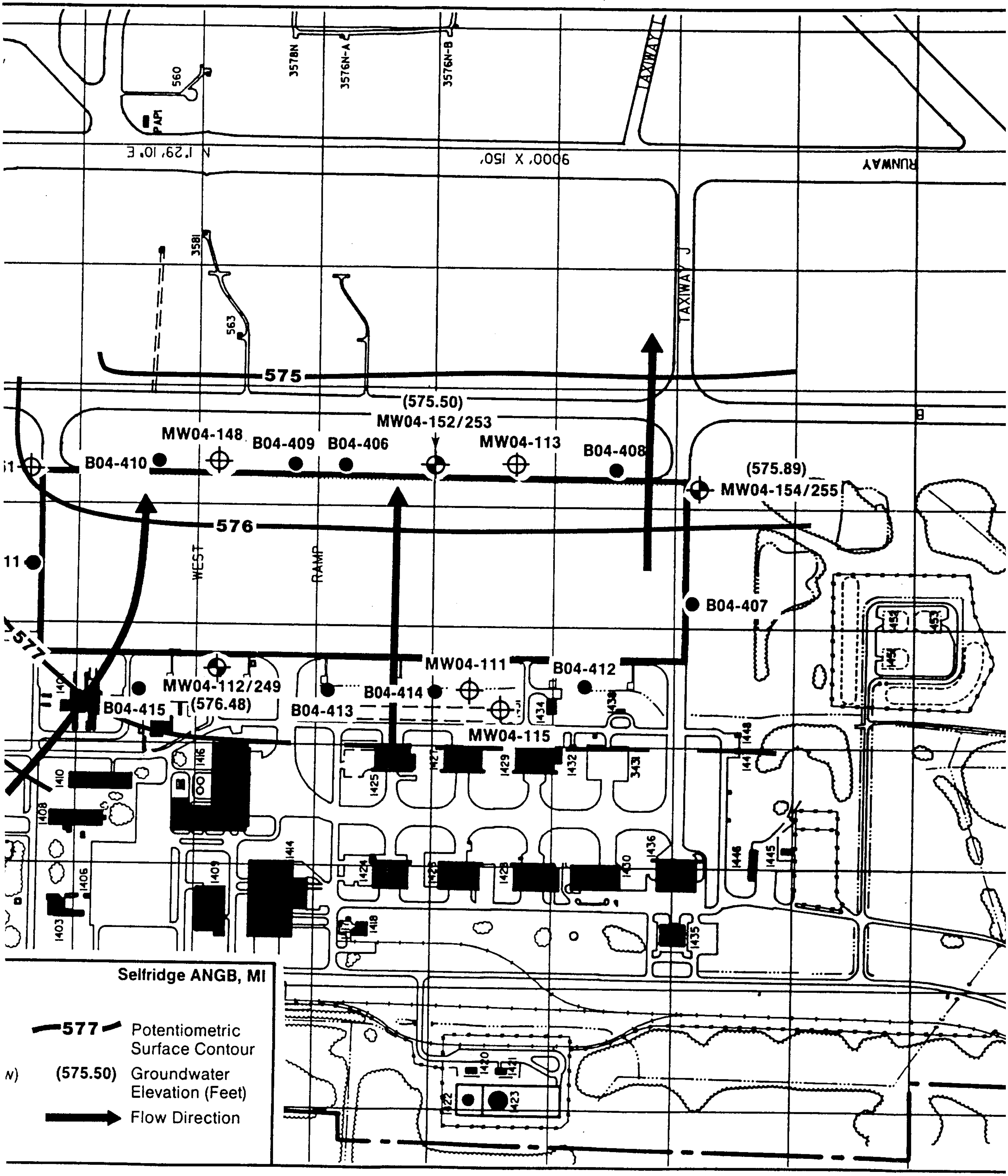


FIGURE 4-48 WRMP/NWLF
POTENTIOMETRIC SURFACE
MAP FOR SHALLOW MONITOR WELLS
ON 1 AUGUST 1988



MW06-144/245
(579.95)
MW06-108
(575.93)
MW06-109
MW04-150/251
MW04-148
B04-409
B04-410
576
575
577
578
579
580
B04-411
(578.51)
MW06-110/247
MW06-146
MW04-112/249
(576.48)
B04-415
B04-413
CLEAR ZONE
TAXIWAY K
NORTH PERIMETER
HALL
WEST RAMP
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW04-150/251 Nested Well Pair (Deep and Shallow)
MW04-148 Shallow Well
B04-412 Soil Boring
577 Potentiometric Surface Contour
(575.50) Groundwater Elevation (Feet)
Flow Direction
0 250 500 1000
Scale in Feet



575
576
577
(575.50)
MW04-152/253
MW04-148
B04-409
B04-406
MW04-113
B04-408
B04-410
(575.89)
MW04-154/255
B04-407
MW04-111
B04-412
MW04-112/249
(576.48)
B04-415
B04-414
B04-413
MW04-115
WEST
RAMP
TAXIWAY J
RUNWAY
9000' X 150'
Selfridge ANGB, MI
577 Potentiometric Surface Contour
(575.50) Groundwater Elevation (Feet)
Flow Direction

FIGURE 4-4

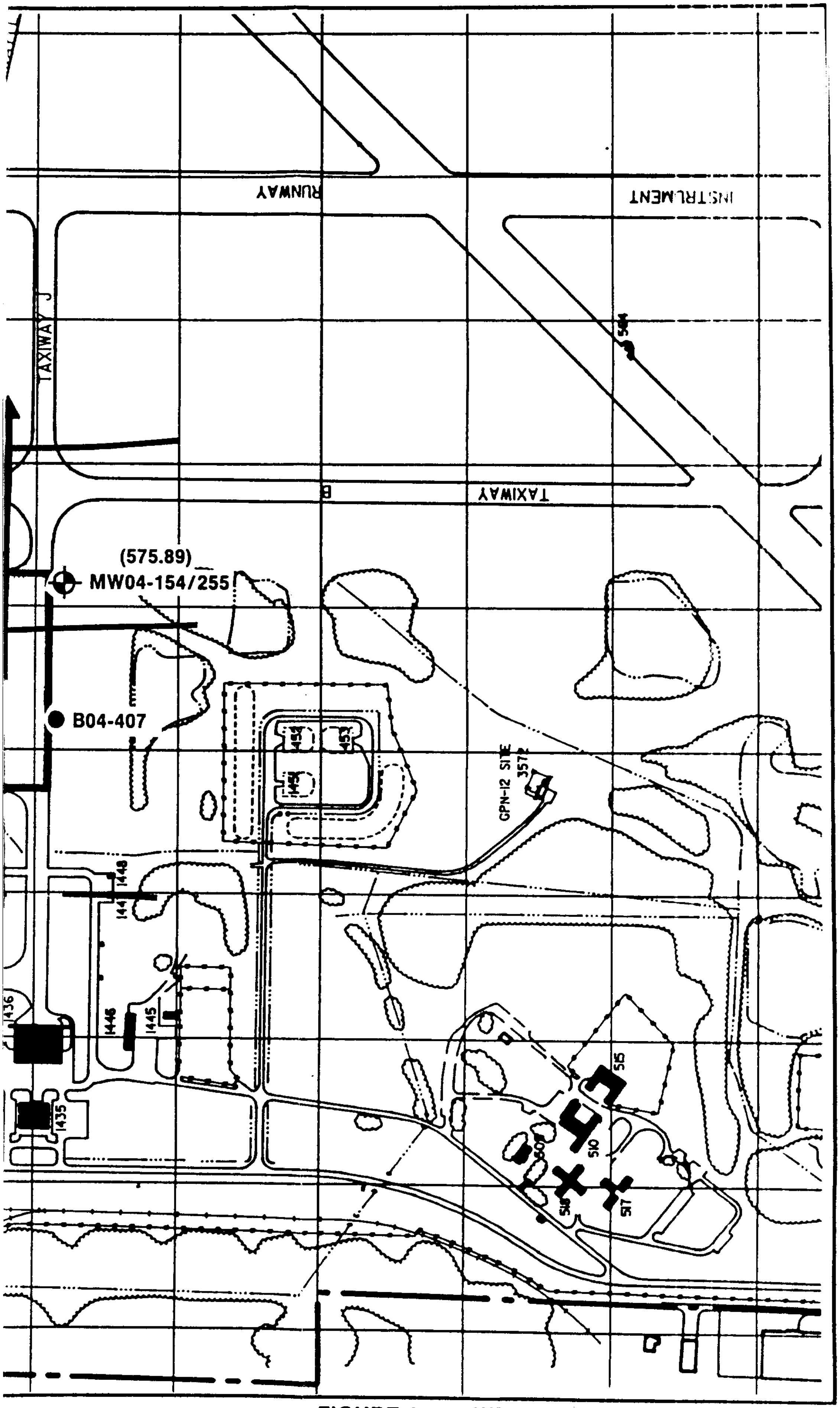


FIGURE 4-49 WRMP/NWLF POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 1 AUGUST 1988

Based upon these values, the linear groundwater flow was 2.29 x 10^{-8} ft/sec (0.72 ft/year) for 21 March 1988. The calculated linear groundwater flow velocity for the deep zone on 21 March 1988 was 4.34 x 10^{-9} ft/sec (0.14 ft/year), using an effective porosity (n) of 15 percent and the average deep well hydraulic conductivity (K). The calculated shallow linear groundwater velocity for 1 August 1988 was 3.06 x 10^{-9} ft/sec (0.10 ft/year), and the linear deep groundwater flow velocity for 1 August 1988 was estimated to be 4.34 x 10^{-9} ft/sec (0.14 ft/year).

Vertical gradients were calculated for all well nests at WRMP using the water levels taken on 1 August 1988. The difference in head between adjacent deep and shallow wells (DH) was divided by the distance between screen centers (D) to obtain the vertical gradient represented as follows:

$$\text{Vertical gradient} = \frac{DH}{D}$$

All four well nests had upward gradients ranging from 0.03 ft/ft for well nest 04-154/255 to 0.19 ft/ft for well nest 04-150/ 251. This matches the general pattern of upward gradients seen throughout the base, indicating upward movement of groundwater for this area.

Generally, water levels in the monitor wells were higher than the surface elevation of Lake St. Clair. Only the water level for monitor well 04-152 was consistently lower than the lake surface elevation. The height of the water levels in the monitor wells above Lake St. Clair ranged from 1.29 to 5.27 feet on 1 February 1988 to 0.95 to 2.72 feet on 1 August 1988. An overall decline in the height of monitor well levels was observed over this period. This decline in water level elevations can be attributed to decreased precipitation and increased evapotranspiration rates between 1 February and 1 August 1988 and interception of groundwater by the stormwater drainage system.

4.7.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- WRMP

The WRMP was designed and built to facilitate rapid drainage of water off the concrete surface. Catch basins along the edge of the concrete surface serve as collection points for the majority of the stormwater runoff and connect to the stormwater drainage system. There are also engineered channels located along the perimeter of the site to convey any stormwater away from the site (see Figure 3-15). Catch basins located in the base of these drainage channels direct the surface flows into the drainage system. In spite of all these measures, not all stormwater is intercepted by the catch basins and ditches, and some water remains on the surface as small stagnant ponds following precipitation.

The stormwater flow is through the stormwater sewer system toward the east to a pump lift station located along Lake St. Clair. At this pump lift station the untreated stormwater runoff is discharged into Lake St. Clair. Any contaminated surface water or infiltrating groundwater collected by the stormwater drainage system would also be discharged into Lake St. Clair. Contaminated surface water could also remain ponded in the engineered drainage channels. Surface water originating from the site may affect the quality of the surface water around the site and in Lake St. Clair.

4.7.1.5 Direct Contact With Contaminated Media -- WRMP

Military and base maintenance personnel have access to the support buildings along the western side of WRMP and are the most likely to come in contact with any contaminants at the site. This includes contaminated surface water and soil, particularly in the area of the fuel spill near well 04-115. No provisions are made to physically restrict persons from access to the site or along its perimeter, but access to the flightline areas of the ramp itself is limited by procedure and policies.

4.7.1.6 Summary of Migration Pathways -- WRMP

Persons working at the WRMP area may come in contact with ponded surface water that may be contaminated. This contact is possible because of routine airplane and ground maintenance activities that occur at WRMP. Contact with contaminated soils may also occur as a result of these activities. Personnel excavating trenches for utility repair or installation could encounter contaminants in the soils.

Based upon the potentiometric surface maps, groundwater flow is generally in an easterly direction. Contaminated groundwater from WRMP would move away from the site and affect areas to the east. The interception of groundwater by the stormwater drainage system provides a rapid means for movement of contaminated groundwater away from the site. Discharge of this water into Lake St. Clair increases the chance of direct contact by humans and aquatic organisms in the lake.

4.7.2 Contamination Profile -- WRMP

4.7.2.1 Chemical Results for Soil -- WRMP

Ten soil borings were drilled at WRMP from which 31 investigative soil and 3 duplicate samples were retained for chemical analyses. These samples were taken from borings drilled around the perimeter of the WRMP adjacent to catch basins connected with the storm sewer drainage system. The borings were drilled at these locations to determine whether the stormwater drainage carried contaminants from the WRMP and left residues in the soils. The soil borings were numbered 04-406 through 04-415. All soil borings were to 30 feet.

The soil borings were drilled and the soils sampled from 20 December 1987 to 5 January 1988. The soils were sent to WESTON/Gulf Coast Laboratories and were analyzed for petroleum hydrocarbons, volatile organics, and soil moisture content. One investigative soil sample taken from 26 to 27 feet (B004) in boring 04-410 was analyzed for EP toxicity only. No holding times were exceeded for these samples. The surrogate recoveries ranged from 70 to 121 percent, and matrix spike recoveries ranged from 32 to 128 percent for the volatile organic analyses. All quantification limits were within acceptable ranges, although the surrogate recoveries and matrix spike recoveries were generally low.

Table 4-45 lists compounds that were detected in validated concentrations in soil samples taken from WRMP. The volatile organic analyses determined that common laboratory and method contaminants acetone (0.015 to 0.14 mg/kg) and methylene chloride (0.011 to 0.075 mg/kg) were detected in valid concentrations in borings 04-407, 04-409, 04-410, and 04-412 through 04-415.

Although acetone occurred in only one soil sample in each of soil borings 04-407, 04-409, and 04-410, almost every soil sample contained acetone or methylene chloride in soil borings 04-412 through 04-415.

Toluene was detected in valid concentrations (<0.002 to 0.014 mg/kg) in soil samples from borings 04-406 through 04-412 and 04-414. A valid concentration of 1,1,1-trichloroethane (<0.002 mg/kg) was detected in sample 04-410-B003. These two compounds are also laboratory contaminants and must be regarded with skepticism at such low concentrations.

Of the other volatile organic compounds analyzed and validated, trace levels of tetrachloroethene (<0.002 to <0.007 mg/kg) were detected in samples 04-409-B003 and 04-410-B003, and trace levels (0.002 to 0.019 mg/kg) of carbon disulfide were detected in eight soil samples from borings 04-407, 04-409, 04-411, and 04-412. Xylenes (0.018 mg/kg) were detected in soil sample 04-413-B001.

Petroleum hydrocarbons were detected in eight soil boring samples taken from the area surrounding the WRMP in concentrations of 74 to 130 mg/kg. These soil samples were collected from the 0- to 3-foot level (04-413), 5- to 10-foot level (04-406, 04-411, and 04-412), the 10- to 18-foot level (04-408, 04-410, and 04-414), and the 20- to 22-foot level (04-407).

4.7.2.2 Chemical Results for Groundwater -- WRMP

One duplicate and 12 investigative groundwater samples were retained for analyses of chemical contaminants during the IRP Stage 2 investigation. They were collected from wells placed around the perimeter of the WRMP during the Phase II Stage 1 and IRP Stage 2 investigations with the intent of detecting

TABLE 4-45

VALID ANALYTES DETECTED IN SOIL AT WRMP,
IRP STAGE 2, SELFRIDGE ANGB, MI

SAMPLE #		04-406-B001			04-406-B002			04-406-B003			04-407-B001			04-407-B002			04-407-B003		
RFW #		120350			120351			120352			120353			120354			120355		
SAMPLE DATE		20-DEC-87			20-DEC-87			20-DEC-87			20-DEC-87			20-DEC-87			20-DEC-87		
DEPTH		0-5 FEET			5-10 FEET			20-23 FEET			6-7.5 FEET			20-22 FEET			24-25.5		
% MOISTURE		23.6			28.2			14.9			21.8			28.5			14.6		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
METHYLENE CHLORIDE	SW5030/SW8240	0.006		NV	0.007		NV	0.006		NV	0.006		NV	0.007		NV	0.006		NV
ACETONE	SW5030/SW8240	0.013		NV	0.014		NV	0.012		NV	0.013	0.015	=	0.014		NV	0.012		NV
CARBON DISULFIDE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.007		ND	0.006	0.004	<
2-BUTANONE	SW5030/SW8240	0.013		ND	0.014		ND	0.012		ND	0.013		ND	0.014		ND	0.012		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.007		ND	0.006		ND
4-METHYL-2-PENTANONE	SW5030/SW8240	0.013		ND	0.014		ND	0.012		ND	0.013		ND	0.014		ND	0.012		ND
TETRACHLOROETHENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.007		ND	0.006		ND
TOLUENE	SW5030/SW8240	0.006	0.003	<	0.007	0.002	<	0.006	0.005	<	0.006	0.002	<	0.007	0.002	<	0.006	0.003	<
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.007		ND	0.006		ND
XYLENES (TOTAL)	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.006		ND	0.007		ND	0.006		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	65.4		ND	62.3	90	=	69.3		ND	63.6		ND	68.9	74	=	58.3		ND

SAMPLE #		04-408-B001			04-408-B101			04-408-B002			04-408-B003			04-409-B001			04-409-B002		
RFW #		120356			120357			120358			120434			120359			120360		
SAMPLE DATE		20-DEC-87			20-DEC-87			21-DEC-87			22-DEC-87			21-DEC-87			21-DEC-87		
DEPTH		0-5 FEET			0-5 FEET			10-15 FEET			25-27.1 FEET			5-10 FEET			15-20 FEET		
% MOISTURE		22.3			23.5			33.2			12.1			32.2			29.6		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
METHYLENE CHLORIDE	SW5030/SW8240	0.006		NV	0.006		NV	0.008		ND	0.006		NV	0.007		ND	0.007		ND
ACETONE	SW5030/SW8240	0.013		NV	0.013		NV	0.015		NV	0.011		NV	0.015		NV	0.014		NV
CARBON DISULFIDE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.007		ND	0.007		ND
2-BUTANONE	SW5030/SW8240	0.013		ND	0.013		ND	0.015		ND	0.011		ND	0.015		ND	0.014		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		NV	0.007		ND	0.007		ND
4-METHYL-2-PENTANONE	SW5030/SW8240	0.013		ND	0.013		ND	0.015		ND	0.011		ND	0.015		ND	0.014		ND
TETRACHLOROETHENE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.007		ND	0.007		ND
TOLUENE	SW5030/SW8240	0.006	0.004	<	0.006		ND	0.008		ND	0.006		ND	0.007		ND	0.007		ND
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.007		ND	0.007		ND
XYLENES (TOTAL)	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.007		ND	0.007		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	64		ND	65.4		ND	74.5	80	=	56.9		ND	73.7		ND	70		ND

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-45

(CONTINUED)

	SAMPLE #	04-409-B002			04-409-B003			04-410-B001			04-410-B002			04-410-B102			04-410-B003		
	RFW #	120361			120435			120362			120363			120364			120365		
	SAMPLE DATE	21-DEC-87			22-DEC-87			21-DEC-87			21-DEC-87			21-DEC-87			21-DEC-87		
	DEPTH	15-20 FEET			25-27.2 FEET			6-8 FEET			14-18 FEET			14-18 FEET			24-25.5 FEET		
	% MOISTURE	30.2			8.7			21.9			31.9			35.2			6.3		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
METHYLENE CHLORIDE	SW5030/SW8240	0.007		NV	0.006		NV	0.006		NV	0.007		NV	0.008		NV	0.005		NV
ACETONE	SW5030/SW8240	0.014	0.036	=	0.011		NV	0.013	0.016	=	0.015		NV	0.015		NV	0.011		NV
CARBON DISULFIDE	SW5030/SW8240	0.007	0.005	<	0.006		ND	0.006		ND	0.007	0.004	<	0.008	0.012	=	0.005		ND
2-BUTANONE	SW5030/SW8240	0.014		ND	0.011		ND	0.013		ND	0.015		ND	0.015		ND	0.011		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.007		ND	0.006		NV	0.006		ND	0.007		ND	0.008		ND	0.005	0.002	<
4-METHYL-2-PENTANONE	SW5030/SW8240	0.014		ND	0.011		ND	0.013		ND	0.015		ND	0.015		ND	0.011		ND
TETRACHLOROETHENE	SW5030/SW8240	0.007		ND	0.006	0.007	=	0.006		ND	0.007		ND	0.008		ND	0.005	0.002	<
TOLUENE	SW5030/SW8240	0.007		ND	0.006	0.006	=	0.006		ND	0.007	0.003	<	0.008	0.004	<	0.005	0.009	=
ETHYLBENZENE	SW5030/SW8240	0.007		ND	0.006		ND	0.006		ND	0.007		ND	0.008		ND	0.005		ND
XYLENES (TOTAL)	SW5030/SW8240	0.007		ND	0.006		ND	0.006		ND	0.007		ND	0.008		ND	0.005		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	71.3		ND	54.5		ND	63.7		ND	72.7		ND	77.2	82	=	52.6		ND

	SAMPLE #	04-411-B001			04-411-B001			04-411-B002			04-411-B003			04-412-B001			04-412-B002		
	RFW #	120436			120437			120438			120439			120440			120441		
	SAMPLE DATE	22-DEC-87			22-DEC-87			22-DEC-87			22-DEC-87			22-DEC-87			22-DEC-87		
	DEPTH	8-10 FEET			8-10 FEET			22-24 FEET			24-25.5 FEET			5-10 FEET			15-20 FEET		
	% MOISTURE	22.5			29.7			31.2			11.8			32.5			19.5		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
METHYLENE CHLORIDE	SW5030/SW8240	0.006		NV	0.006		NV	0.007		ND	0.006		NV	0.007		ND	0.006		NV
ACETONE	SW5030/SW8240	0.013		NV	0.012		NV	0.014		NV	0.011		NV	0.015		ND	0.012	0.044	=
CARBON DISULFIDE	SW5030/SW8240	0.006	0.011	=	0.006	0.006	=	0.007	0.01	=	0.006	0.002	<	0.007	0.019	=	0.006	0.007	=
2-BUTANONE	SW5030/SW8240	0.013		ND	0.012		ND	0.014		ND	0.011		ND	0.015		ND	0.012		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		ND	0.006		NV	0.007		NV	0.006		NV	0.007		NV	0.006		NV
4-METHYL-2-PENTANONE	SW5030/SW8240	0.013		ND	0.012		ND	0.014		ND	0.011		ND	0.015		ND	0.012		ND
TETRACHLOROETHENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.006		ND	0.007		ND	0.006		ND
TOLUENE	SW5030/SW8240	0.006	0.006	=	0.006	0.004	<	0.007		ND	0.006	0.005	<	0.007		ND	0.006	0.002	<
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.006		ND	0.007		ND	0.006		ND
XYLENES (TOTAL)	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.006		ND	0.007		ND	0.006		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	64.2		ND	70.8	89	=	71.9		ND	56.1		ND	73.7	130	=	61.5		ND

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-45

(CONTINUED)

ANALYTE	METHOD	04-412-B003 DL	R	QL	04-413-B001 DL	R	QL	04-413-B002 DL	R	QL	04-413-B003 DL	R	QL	04-413-B103 DL	R	QL	04-414-B001 DL	R	QL
RFW #		120442			121082			121083			121084			121085			121086		
SAMPLE DATE		22-DEC-87			04-JAN-88			04-JAN-88			05-JAN-88			05-JAN-88			05-JAN-88		
DEPTH		25-28.5 FEET			0-3 FEET			10-15 FEET			25-28 FEET			25-28 FEET			2-3 FEET		
% MOISTURE		13.0			23.3			33.9			15.2			17.9			19.8		
		DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
METHYLENE CHLORIDE	SW5030/SW8240	0.006		ND	0.006		NV	0.008		NV	0.006	0.019	=	0.006	0.018	=	0.006	0.015	=
ACETONE	SW5030/SW8240	0.012	0.034	=	0.013	0.11	=	0.015	0.049	=	0.012	0.11	=	0.012	0.12	=	0.012		NV
CARBON DISULFIDE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.006		ND	0.006		ND
2-BUTANONE	SW5030/SW8240	0.012		ND	0.013		ND	0.015		ND	0.012		ND	0.012		ND	0.012		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		NV	0.006		ND	0.008		ND	0.006		ND	0.006		ND	0.006		ND
4-METHYL-2-PENTANONE	SW5030/SW8240	0.012		ND	0.013		ND	0.015		ND	0.012		ND	0.012		ND	0.012		ND
TETRACHLOROETHENE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.006		ND	0.006		ND
TOLUENE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.006		ND	0.006	0.014	=
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.008		ND	0.006		ND	0.006		ND	0.006		ND
XYLENES (TOTAL)	SW5030/SW8240	0.006		ND	0.006	0.018	=	0.008		ND	0.006		ND	0.006		ND	0.006		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	57.2		ND	64.5	82	=	74.9		ND	58.1		ND	60.6		ND	62.3		ND

ANALYTE	METHOD	04-414-B003 DL	R	QL	04-414-B004 DL	R	QL	04-415-B001 DL	R	QL	04-415-B001 DL	R	QL	04-415-B002 DL	R	QL	04-415-B003 DL	R	QL
RFW #		121092			121093			121088			121089			121090			121091		
SAMPLE DATE		05-JAN-88			05-JAN-88			05-JAN-88			05-JAN-88			05-JAN-88			05-JAN-88		
DEPTH		13-17.5 FEET			13-17.5 FEET			5-10 FEET			5-10 FEET			15-19.5 FEET			25-30 FEET		
% MOISTURE		28.9			20.8			34.5			33.0			33.7			6.2		
		DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
METHYLENE CHLORIDE	SW5030/SW8240	0.008		ND	0.006	0.011	=	0.008	0.038	=	0.007	0.012	=	0.008		NV	0.005	0.075	=
ACETONE	SW5030/SW8240	0.015	0.083	=	0.013	0.13	=	0.015	0.14	=	0.015	0.08	=	0.015	0.097	=	0.011	0.074	=
CARBON DISULFIDE	SW5030/SW8240	0.008		ND	0.006		ND	0.008		ND	0.007		ND	0.008		ND	0.005		ND
2-BUTANONE	SW5030/SW8240	0.015		ND	0.013		ND	0.015		ND	0.015		ND	0.015		ND	0.011		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.008		ND	0.006		ND	0.008		ND	0.007		ND	0.008		ND	0.005		ND
4-METHYL-2-PENTANONE	SW5030/SW8240	0.015		ND	0.013		ND	0.015		ND	0.015		ND	0.015		ND	0.011		ND
TETRACHLOROETHENE	SW5030/SW8240	0.008		ND	0.006		ND	0.008		ND	0.007		ND	0.008		ND	0.005		ND
TOLUENE	SW5030/SW8240	0.008		ND	0.006		ND	0.008		ND	0.007		ND	0.008		ND	0.005		ND
ETHYLBENZENE	SW5030/SW8240	0.008		ND	0.006		ND	0.008		ND	0.007		ND	0.008		ND	0.005		ND
XYLENES (TOTAL)	SW5030/SW8240	0.008		ND	0.006		ND	0.008		ND	0.007		ND	0.008		ND	0.005		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	69.6	80	=	63.1		ND	75.2		ND	73.5		ND	75		ND	53.3		ND

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

groundwater contamination from plane refueling and maintenance operations. The groundwater samples were collected from 9 April to 13 April 1988.

The groundwater samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, petroleum hydrocarbons, common anions, alkalinity, and TDS. No holding times were exceeded for these samples. All the wells were resampled for analysis of nitrate/nitrite on 6 August 1988. No holding times were exceeded for these samples.

Surrogate recoveries for purgeable aromatics analyses ranged from 52 to 104 percent, and matrix spike recoveries ranges from 70 to 132 percent. All surrogate recoveries, matrix spike recoveries, and detection limits were within quality control limits.

Table 4-46 lists validated compounds detected in groundwater samples collected at WRMP. The volatile organic compound benzene was detected and confirmed in 04-112-M001 at trace concentrations (2 ug/L). In addition, petroleum hydrocarbons were detected in 04-112-M001 and 04-152-M001 at 2 mg/L. No other purgeable aromatics or petroleum hydrocarbons were detected in the groundwater samples from WRMP.

Chloride concentrations occurred above background ranges in wells 04-111 (201 mg/L), 04-255 (385 mg/L), 04-249 (415 mg/L), and 04-253 (328 mg/L). Sulfate occurred in background concentrations (3.6 to 107 mg/L) in every sample except 04-112-M001 (298 mg/L) and 04-150-M001 (962 mg/L). The sulfate concentration for 04-150-M001 was the highest that occurred during the IRP Stage 2 investigation. The highest TDS concentrations at WRMP also occurred in samples 04-112-M001 (1,000 mg/L) and 04-150-M001 (1,400 mg/L). Other concentrations of TDS were within background ranges (380 to 880 mg/L). Alkalinity occurred within background ranges (180 to 610 mg/L). Nitrate/ nitrite was not detected. Some of the chloride (>250 mg/L), sulfate (>250 mg/L), and TDS (>500 mg/L) concentrations detected at WRMP were above secondary drinking water standards.

4.7.2.3 Chemical Results for Surface Water -- WRMP

Four surface water stations were established at WRMP. They were placed at critical junctions and thus monitored all of the surface water that flowed from WRMP into the stormwater sewers. Four investigative and one duplicate surface water samples were collected on 20 April 1988 after an extended dry period, and four investigative and one duplicate surface water samples were collected on 10 May 1988 after a significant rain event.

The surface water samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, petroleum

TABLE 4-46

VALID ANALYTES DETECTED IN GROUNDWATER AT WRMP,
IRP STAGE 2, SELFRIDGE ANGB, MI

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE # / RFW # / SAMPLE DATE		04-111-M001 127955 11-APR-88			04-112-M001 127963 11-APR-88			04-113-M001 128052 12-APR-88			04-115-M001 127956 11-APR-88			04-115-M101 127957 11-APR-88			04-148-M001 128053 12-APR-88		
BENZENE	SW5030/SW8020	ug/L	2		ND	2	2 (2)	=	2		ND	2		ND	2		ND	2		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.04		ND	1.05	2	=	1.03		ND	1.02		ND	1.03		ND	1.02		ND
ALKALINITY	A403	mg/L	10	190	=	10	500	=	10	180	=	10	540	=	10	540	=	10	400	=
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	440	=	10	1000	=	10	380	=	10	580	=	10	560	=	10	710	=
	SAMPLE # / RFW # / SAMPLE DATE		04-111-M001 8804-069-003 11-APR-88			04-112-M001 8804-069-010 11-APR-88			04-113-M001 8804-092-005 12-APR-88			04-115-M001 8804-069-004 11-APR-88			04-115-M101 8804-069-005 11-APR-88			04-148-M001 8804-092-006 12-APR-88		
CHLORIDE	A429	mg/L	25	201	=	25	65.4	=	25	55.3	=	25	68.7	=	25	67.6	=	25	60.4	=
SULFATE	A429	mg/L	2.5	6.7	=	25	298	=	25	95.1	=	2.5	36.2	=	2.5	36.3	=	25	107	=
	SAMPLE # / RFW # / SAMPLE DATE		04-111-M001 137219 06-AUG-88			04-112-M001 137224 06-AUG-88			04-113-M001 137214 06-AUG-88			04-115-M001 137225 06-AUG-88			04-111-M101 137220 06-AUG-88			04-148-M001 137211 06-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1		ND	0.1		ND	0.1		ND	0.1		ND	0.1		ND

DL - SAMPLE DETECTION LIMIT
R - RESULTS
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-46

(CONTINUED)

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE # / RFW # / SAMPLE DATE		04-150-M001 127962 11-APR-88			04-152-M001 128174 13-APR-88			04-154-M001 127857 09-APR-88			04-249-M001 127960 11-APR-88			04-251-M001 127859 09-APR-88			04-253-M001 127860 09-APR-88		
BENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND	2		ND	2		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.06		ND	1.00	2	=	1.00		NV	1.10		NV	1.12		NV	1.10		NV
ALKALINITY	A403	mg/L	10	300	=	10	460	=	10	610	=	10	230	=	10	180	=	10	220	=
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	1400	=	10	620	=	10	880	=	10	810	=	10	380	=	10	750	=
	SAMPLE # / RFW # / SAMPLE DATE		04-150-M001 8804-069-009 11-APR-88			04-152-M001 8804-113-001 13-APR-88			04-154-M001 8804-053-007 09-APR-88			04-249-M001 8804-069-007 11-APR-88			04-251-M001 8804-053-008 09-APR-88			04-253-M001 8804-053-009 09-APR-88		
CHLORIDE	A429	mg/L	2.5	33.3	=	25	114	=	2.5	22.9	=	25	415	=	12.5	127	=	62.5	328	=
SULFATE	A429	mg/L	62.5	962	=	2.5	36.8	=	2.5	46.8	=	25	76.4	=	2.5	4	=	2.5		ND
	SAMPLE # / RFW # / SAMPLE DATE		04-150-M001 137212 06-AUG-88			04-152-M001 137226 06-AUG-88			04-154-M001 137228 06-AUG-88			04-249-M001 137230 06-AUG-88			04-251-M001 137213 06-AUG-88			04-253-M001 137227 06-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1		ND	0.2		ND	0.2		ND	0.2		ND	0.2		ND

DL - SAMPLE DETECTION LIMIT
R - RESULTS
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-46

(CONTINUED)

ANALYTE	METHOD	UNIT	DL	R	QL
	SAMPLE #		04-255-M001		
	RFW #		127961		
	SAMPLE DATE		10-APR-88		
BENZENE	SW5030/SW8020	ug/L	2		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.04		NV
ALKALINITY	A403	mg/L	10	210	=
FLUORIDE	E340.2	mg/L	0.1		NV
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	640	=
	SAMPLE #		04-255-M001		
	RFW #		8804-069-008		
	SAMPLE DATE		10-APR-88		
CHLORIDE	A429	mg/L	25	385	=
SULFATE	A429	mg/L	2.5	3.6	=
	SAMPLE #		04-255-M001		
	RFW #		137219		
	SAMPLE DATE		06-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.2		ND

DL - SAMPLE DETECTION LIMIT
R - RESULTS
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

hydrocarbons, common anions, alkalinity, and TDS. Holding times were exceeded for TDS analyses for all the wet-event samples. The surface water stations were resampled on 3 August 1988 (wet event) for TDS and nitrate/nitrite and on 8 August 1988 (dry event) for nitrate/nitrite. Surface water was sampled for nitrate/nitrite during the resampling because it was not sampled for during the initial sampling round. No holding times were exceeded for these samples.

Surrogate recoveries for purgeable aromatics analyses ranged from 84 to 108 percent. All surrogate recoveries and detection limits were within quality control limits.

Table 4-47 lists the validated compounds detected in surface water collected at WRMP. Analyses of surface water samples 04-512-W001 and 04-512-W101 detected and confirmed the presence of 1,4-dichlorobenzene in trace concentrations (7 to 8 ug/L). No other purgeable aromatics were detected in surface water samples. Samples taken during the dry event detected valid concentrations of petroleum hydrocarbons in all samples, ranging from 1.5 to 2.0 mg/L. Samples taken during the wet event contained concentrations of petroleum hydrocarbons in similar ranges, but were invalidated as petroleum hydrocarbons were detected in the associated equipment blanks. Chloride (6.5 to 62.2 mg/L) and sulfate (15.7 to 75.0 mg/L) were detected in low background concentrations from both sampling events. Alkalinity (260 to 480 mg/L) and TDS (330 to 500 mg/L) occurred in background concentrations from both sampling events.

4.7.3 Extent of Contamination -- WRMP

During the Phase II Stage 1 investigation 15 soil samples were retained for analyses of oil and grease and volatile organics from 5 soil borings drilled at evenly spaced locations around the perimeter of WRMP. The samples were retained from the 2.5-, 7.5-, and 10.5-foot depths in each of the 5 borings. The analyses detected benzene (<4.0 to 24 mg/kg), chloroethane (<2.0 to 31 mg/kg), chloroform (<2.0 to 13 mg/kg), ethylbenzene (<2.0 to 5.2 mg/kg), methylene chloride (<3.0 to 98 mg/kg), toluene (<2.0 to 5.2 mg/kg), 1,1,1-trichloroethene (60 to 1,500 mg/kg), trichlorofluoromethane (<3.0 to 100 mg/kg), and oil and grease (65 to 17,900 mg/kg). With one exception, every soil sample analyzed contained trichloroethene, and all contained one or two solvents within the concentration ranges cited above. The only distinctive pattern of contamination readily observable was in samples from 07-115, which was placed adjacent to the source of the January 1984 spill. The 2.5- and 7.5-foot samples from this boring contained oil and grease (17,900 mg/kg), and toluene (25,000 and 104,000 mg/kg), as well as other solvents. Samples from this boring were also analyzed for hazardous waste characteristics and were found to be nonignitable.

TABLE 4-47

VALID ANALYTES DETECTED IN DRY-EVENT SURFACE WATER AT WRMP,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE		04-510-W001 128926 20-APR-88			04-511-W001 128927 20-APR-88			04-512-W001 128928 20-APR-88			04-512-W101 128929 20-APR-88			04-513-W001 128932 20-APR-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
1,4-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5	8 (6)	=	5	7 (5)	=	5		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.09	1.6	=	1.02	1.5	=	1.04	1.9	=	1.03	2	=	1.05	1.9	=
ALKALINITY	A403	mg/L	10	460	=	10	320	=	10	320	=	10	320	=	10	300	=
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT	10		HT
	SAMPLE # / RFW # / SAMPLE DATE		04-510-W001 8804-183-021 20-APR-88			04-511-W001 8804-183-022 20-APR-88			04-512-W001 8804-183-023 20-APR-88			04-512-W101 8804-183-024 20-APR-88			04-513-W001 8804-183-026 20-APR-88		
CHLORIDE	A429	mg/L	2.5	6.5	=	2.5	8	=	25	62	=	25	62.2	=	25	43.3	=
SULFATE	A429	mg/L	2.5	15.8	=	2.5	50.8	=	2.5	55.1	=	25	48.2	=	2.5	33.1	=
	SAMPLE # / RFW # / SAMPLE DATE		04-510-W001 137317 08-AUG-88			04-511-W001 137319 08-AUG-88			04-512-W001 137321 08-AUG-88						04-513-W001 137323 08-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1	0.7	=	0.1	0.8	=	0.1	1.2	=				0.1	0.6	=
	SAMPLE # / RFW # / SAMPLE DATE		04-510-W021 137318 08-AUG-88			04-511-W021 137320 08-AUG-88			04-512-W021 137322 08-AUG-88						04-513-W021 137324 08-AUG-88		
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	500	=	10	460	=	10	460	=				10	470	=

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NUMBER IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-47 (CONTINUED)

VALID ANALYTES DETECTED IN WET-EVENT SURFACE WATER AT WRMP

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE #		04-510-W002			04-511-W002			04-512-W002			04-512-W102			04-513-W002		
	RFW #		130192			130193			130194			130195			130198		
	SAMPLE DATE		10-MAY-88			10-MAY-88			10-MAY-88			10-MAY-88			10-MAY-88		
1,4-DICHLOROBENZENE	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND	5		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00		NV	1.00		NV	1.02		NV	1.00		NV	1.01		NV
ALKALINITY	A403	mg/L	10	410	=	10	270	=	10	260	=	10	260	=	10	480	=
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	460	=	10	330	=	10	510	=	10	440	=	10	420	=
	SAMPLE #		04-510-W002			04-511-W002			04-512-W002			04-512-W102			04-513-W002		
	RFW #		8805-386-005			8805-386-006			8805-386-007			8805-386-008			8805-386-010		
	SAMPLE DATE		10-MAY-88			10-MAY-88			10-MAY-88			10-MAY-88			10-MAY-88		
CHLORIDE	A429	mg/L	2.5	9.5	=	2.5	11.9	=	25	52	=	25	50	=	2.5	29	=
SULFATE	A429	mg/L	2.5	15.7	=	2.5	56.2	=	25	75	=	25	74	=	25	49	=
	SAMPLE #		04-510-W002			04-511-W002			04-512-W002						04-513-W002		
	RFW #		136826			136827			136828						136829		
	SAMPLE DATE		03-AUG-88			03-AUG-88			03-AUG-88						03-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1	0.4	=	0.1	0.8	=	0.1	1.0	=				0.1	0.6	=

DL - SAMPLE DETECTION LIMIT
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QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBER IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

The IRP Stage 2 investigation sampled soils from 10 borings adjacent to catch basins of the storm sewer drainage system. A number of solvents were detected in the analyses, including carbon disulfide (<0.004 to 0.019 mg/kg), acetone (0.015 to 0.14 mg/kg), methylene chloride (0.011 to 0.075 mg/kg), toluene (<0.002 to 0.014 mg/kg), xylenes (0.018 mg/kg), tetrachloroethene (<0.004 to 0.012 mg/kg), and 1,1,1-trichloroethane (<0.002 to 0.007 mg/kg) (see Table 4-46). Several samples from boring 04-112, which was placed near the January 1984 fuel spill, contained the highest concentrations of petroleum hydrocarbons detected at WRMP during the IRP Stage 2 investigation. A floating oil layer was noted on groundwater that filled this boring prior to grouting. No trichloroethene was detected in any sample analyzed from the WRMP during the IRP Stage 2 investigation. This suggests that the trichloroethene detected in all the Phase II Stage 1 soil samples is no longer detectable due to natural removal and destruction processes.

The pervasive presence of oil and grease, petroleum hydrocarbons, and chlorinated solvents in most of the soils sampled at WRMP indicates that the soils, at least to a depth of 30 feet, have been contaminated by operations at WRMP. The soils have probably received multiple releases of fuels and degreasing contaminants. The high concentrations of oil and grease, petroleum hydrocarbons, and toluene around monitor well 04-115 and soil boring 04-412, plus the presence of a petroleum layer on the groundwater filling boring 04-412, indicate that some of the upper layers of soil contain residual petroleum hydrocarbons potentially from the January 1984 fuel spill as well as other smaller spills. A layer of oil may have formed on the capillary fringe just above the water table. The volume of soil affected by fuel can not be calculated exactly since the area of the spill is unknown. However, from calculations in Subsection 4.2.2.4 it is known that 6,000 gallons of JP-4 (estimated volume of 1984 spill) can saturate an estimated 1,090 cubic yards of soil, or 1,928 tons. It is estimated that natural processes have removed at least 80 percent of the JP-4, leaving about 1,200 gallons remaining in the soil, based upon the emissions calculations in Subsection 4.2.3.1 and the biodegradation rates listed in Subsection 4.2.3.3. It is appropriate to assume that most of the contaminated soil is no longer at saturation capacity because of natural removal and migration processes. However, the extent of affected soil is probably greater than 1,090 tons because of migration processes. Contaminant migration rates are calculated for WRMP later in this subsection. Analyses of the rest of the soil indicate no other area of a similar nature at WRMP.

The IRP Stage 2 investigation detected some contaminants around the storm sewer catch basins, but not in concentrations that are found in areas of known fuel spillage, such as at boring 04-412. This indicates that the storm sewer, surface water

drainage ditches, and natural processes have removed fuel and degreasing contaminants from the areas around the catch basins, and thus WRMP, or the contaminants have remained trapped in the soils near the locations of spills and have not been mobilized to the catch basins.

Groundwater was sampled from five monitor wells (04-111 through 04-115) during the Phase II Stage 1 investigation and was analyzed for volatile organics, TOC, and petroleum hydrocarbons. Petroleum hydrocarbons (1.0 to 2.4 mg/L) were detected in all the groundwater samples, and trichloroethene (2.3 to 2.5 ug/L) was detected in wells 04-111 and 04-114.

The IRP Stage 2 investigation sampled 12 wells for groundwater, including 8 newly constructed wells and 4 Phase II Stage 1 wells. Well 04-114 had been destroyed by base operations before the IRP Stage 2 investigation commenced and, therefore, was not resampled. None of the wells sampled during the IRP Stage 2 investigation contained trichloroethene (see Table 4-46). Monitor well 04-112 also contained benzene (2 ug/L). Monitor well 04-115, the well nearest the January 1984 fuel spill, did not contain any organic contaminants. Based upon the results of both stages of investigation, the groundwater around WRMP is either intermittently contaminated or intermittently observed to contain detectable concentrations of hydrocarbons resulting from fuel spills and other operations. The intermittent nature of the observed contamination may be due to seasonal fluctuations in the groundwater and/or the removal of hydrocarbon contaminants from the soils by natural processes. As these contaminants are occuring in concentrations close to detection limits, a slight change in their concentrations in the soil-groundwater system could result in their not being detected by the sampling.

Monitor wells 04-112 and 04-150 contained TDS and sulfate concentrations above secondary drinking water standards. Monitor wells 04-255, 04-249, and 04-253 contained chloride concentrations above secondary drinking water standards. The presence of these elevated parameters does not appear to follow any pattern. However, 04-150 contained the highest sulfate concentration (962 mg/L) detected on base. It is located on the northern side of the WRMP, placing it close to NWLF. However, migration rates calculated for landfill leachate at NWLF suggest that contaminants from NWLF have not migrated as far south as well 04-150. The high TDS, sulfate, and chloride concentrations may be due to snow removal operations around WRMP.

Potentiometric maps of groundwater flow indicate that, for both deep and shallow wells, the groundwater flows to the southeast in the northern section of the WRMP and to the east for the rest of the WRMP. The extensive stormwater drainage system around the WRMP acts to truncate the potentiometric surface and almost makes WRMP a local groundwater depression.

The hydraulic conductivities determined for the wells at Selfridge ANGB indicate very slow flow rates. Calculated velocities were from 0.10 to 0.72 ft/year for the shallow wells and 0.14 ft/year for the deep wells, as discussed in Subsection 4.7.1.3. Based upon the retardation equation discussed in Subsection 4.2.2.4 and using constituents (benzene) that are common in JP-4, the maximum migration rate for contaminants in the groundwater is 0.35 ft/year. An effective porosity of 15 percent and 0.1 percent carbon in soil was used for this calculation. The maximum extent contaminants could have migrated is approximately 17.5 feet (Selfridge ANGB has been in operation at least 50 years) using this rate. Calculations using higher soil carbon concentrations (such as 1.0 percent) mean even slower migration rates. This very slow migration rate indicates that groundwater migration is not a primary method for contaminant transport away from the WRMP. It may also be a reason that the soils did not appear to be highly contaminated around the stormwater catch basins, as the basins are 50 to 100 feet from the actual ramp. Migration rates are so slow as to be prohibitive for contaminants to traverse the distance from the spill sites (such as at the fuel pumping stations) to catch basin areas via the movement of groundwater.

Surface water was not sampled during the Phase II Stage 1 investigation at WRMP. Four surface water sampling stations were established during the IRP Stage 2 investigation at WRMP. The surface water sampled during the dry event at WRMP contained petroleum hydrocarbons (1.5 to 2.0 mg/L) at all four stations. However, the petroleum hydrocarbons detected in the wet-event samples were invalidated by the presence of petroleum hydrocarbons in the associated equipment blank. Station 04-512 also contained 1,4-dichlorobenzene (8 ug/L) during the dry-event sampling. This station receives all the stormwater from the NWLF and the WRMP. Therefore, it is uncertain that the 1,4-dichlorobenzene is a contaminant from WRMP. The pervasive presence of petroleum hydrocarbons in the surface water during the dry sampling event indicates that the storm sewers are transporters of fuel contaminants from the WRMP.

No applicable standards were exceeded by analytes in soils at WRMP. The only analytes detected in groundwater which exceeded applicable standards were benzene and TDS (see Table 4-48). The benzene concentration in sample 04-112-M001 exceeded the Safe Drinking Water Act MCL. All groundwater samples exceeded the potential international chemical-specific ARARs for TDS. Several dry- and wet-event surface water samples also had TDS concentrations in excess of the potential international chemical-specific ARARs (see Table 4-49).

4.7.4 Qualitative Risk Assessment -- WRMP

The WRMP sampling data indicate contamination of subsurface soils and limited contamination of site groundwater and surface

Table 4-48

Analyte Concentrations in WRMP Groundwater Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Benzene		N/A	N/A	N/A	N/A	N/A	N/A
04-112-M001	2×10^{-3}	---	---	---	---	---	---
TDS		2.0×10^{2}	N/A	N/A	N/A	N/A	N/A
04-111-M001	4.4×10^{2}	X	---	---	---	---	---
04-112-M001	1.0×10^{3}	X	---	---	---	---	---
04-113-M001	3.8×10^{2}	X	---	---	---	---	---
04-115-M001	5.8×10^{2}	X	---	---	---	---	---
04-115-M010	5.6×10^{2}	X	---	---	---	---	---
04-148-M001	7.1×10^{2}	X	---	---	---	---	---
04-150-M001	1.4×10^{3}	X	---	---	---	---	---
04-152-M001	6.2×10^{2}	X	---	---	---	---	---
04-154-M001	8.8×10^{2}	X	---	---	---	---	---
04-249-M001	8.1×10^{2}	X	---	---	---	---	---
04-251-M001	3.8×10^{2}	X	---	---	---	---	---
04-253-M001	7.5×10^{2}	X	---	---	---	---	---
04-255-M001	6.4×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreememt Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-48
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Benzene		N/A	N/A	0	0	N/A
04-112-M0001	2×10^{-3}	---	---	X	X	X
TDS		N/A	N/A	N/A	N/A	N/A
04-111-M001	4.4×10^{2}	---	---	---	---	---
04-112-M001	1.0×10^{3}	---	---	---	---	---
04-113-M001	3.8×10^{2}	---	---	---	---	---
04-115-M001	5.8×10^{2}	---	---	---	---	---
04-115-M010	5.6×10^{2}	---	---	---	---	---
04-148-M001	7.1×10^{2}	---	---	---	---	---
04-150-M001	1.4×10^{3}	---	---	---	---	---
04-152-M001	6.2×10^{2}	---	---	---	---	---
04-154-M001	8.8×10^{2}	---	---	---	---	---
04-249-M001	8.1×10^{2}	---	---	---	---	---
04-251-M001	3.8×10^{2}	---	---	---	---	---
04-253-M001	7.5×10^{2}	---	---	---	---	---
04-255-M001	6.4×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-49

Analyte Concentrations in WRMP Surface Water Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
TDS		2.0×10^2	N/A	N/A	N/A	N/A	N/A
04-510-W021	5.0×10^2	X	---	---	---	---	---
04-511-W021	4.6×10^2	X	---	---	---	---	---
04-512-W021	4.6×10^2	X	---	---	---	---	---
04-513-W021	4.7×10^2	X	---	---	---	---	---
04-510-W002	4.6×10^2	X	---	---	---	---	---
04-511-W002	3.3×10^2	X	---	---	---	---	---
04-512-W002	5.1×10^2	X	---	---	---	---	---
04-512-W102	4.4×10^2	X	---	---	---	---	---
04-513-W002	4.2×10^2	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreememt Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-49
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
IDS	N/A	N/A	N/A	N/A	N/A	N/A
04-510-W021	5.0×10^2	---	---	---	---	---
04-511-W021	4.6×10^2	---	---	---	---	---
04-512-W021	4.6×10^2	---	---	---	---	---
04-513-W021	4.7×10^2	---	---	---	---	---
04-510-W002	4.6×10^2	---	---	---	---	---
04-511-W002	3.3×10^2	---	---	---	---	---
04-512-W002	5.1×10^2	---	---	---	---	---
04-512-W102	4.4×10^2	---	---	---	---	---
04-513-W002	4.2×10^2	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

water. Nine contaminants of concern out of a total of 12 individual chemical species detected on site were identified by the EPA indicator chemical selection process and are listed in Table 4-50.

The following migration pathways for movement of contamiants from WRMP have been identified:

- Soil --> groundwater
- Soil --> groundwater--> stormwater drainage system --> surface water

Access to this site is limited as it is on the flightline. However, it is estimated that over 100 persons are within 1,000 feet of the site perimeter on a day-to-day basis in adjacent hangars and administrative buildings.

Surface water samples from this site were taken from the underlying base stormwater drainage system. Analyses of this water revealed limited contamination, and the only contaminant of concern indentified was 1,4-dichlorobenzene. This contaminant was present at levels well below the Maximum Contaminant Level for this compound established by the Safe Drinking Water Act. The groundwater samples from the WRMP site were found to be slightly more contaminated than surface water, with methylene chloride present at levels exceeding the proposed EPA media protection standards and benzene present at levels that exceed EPA ambient water quality criteria for the protection of human health.

As with other sites on base, the stormwater drainage system that serves this site is believed to receive a significant volume of water from groundwater seepage. Direct contact with groundwater is not considered a potential exposure pathway because no wells are used on base. However, potential accumulation of contaminated groundwater by the stormwater drainage system as well as other sources may potentially result in discharge of water into Lake St. Clair, with concentrations of contaminants that exceed Federal standards or recommendations. Although this discharge will be rapidly diluted by the high water volume of Lake St. Clair, the potential for contact with high concetrations of contaminants in water exists for downstream receptors. This includes recreational surface water users and biota within Lake St. Clair.

Two major fuel spills related to the malfunction of pumping equipment were reported in this area. Soil contamination on this site is subsurface in nature and does not represent a direct contact hazard to base personnel. However, a landscaped grassy area on the western side of the ramp area contains a depression that accumulates water when it rains. Base personnel have noted fuel odors in this area during wet periods.

Table 4-50

Contaminants of Concern at WRMP, IRP Stage 2, Selfridge ANGB, MI

Contaminant	Maximum Concentration Detected in Medium: Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
1,1,1-Trichloroethane	0.000005		
1,4-Dichlorobenzene			0.008
Acetone[a]	0.00015		
Benzene[b]		0.002[c]	
Carbon disulfide[a]	0.000019		
Methylene chloride[a]	0.000075	0.003[d]	
Tetrachloroethene[b]	0.000007		
Toluene	0.000014		
Xylenes	0.000035		

[a]No Federal or state criteria exist at present for contaminant levels in groundwater or surface water.
[b]Known/suspected carcinogen (oral route).
[c]Exceeds EPA ambient water quality criteria for the protection of human health.
[d]Exceeds proposed EPA media protection standards.

Exposure to airborne contaminants released from subsurface soils probably does not represent a hazard at this site because of anticipated slow release and rapid dilution rates. However, if contaminated subsurface soils are exposed, the inhalation exposure pathway must be evaluated by collection of ambient air monitoring data.

4.8 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- TUCKER CREEK LANDFILL

4.8.1 Pathway Characterization and Migration Potential -- TCLF

4.8.1.1 Subsurface Conditions -- TCLF

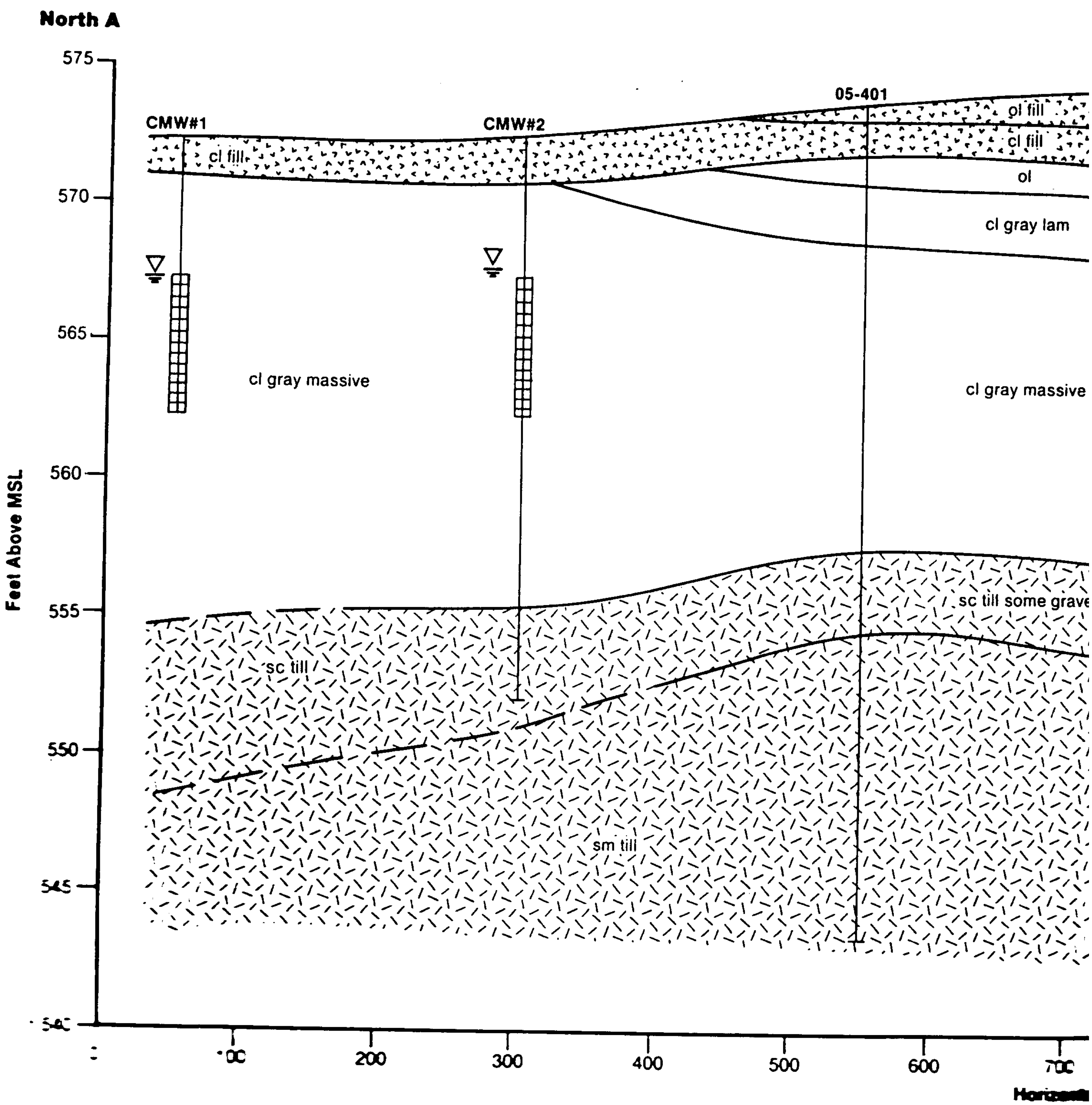
The surficial soil type at the site is mapped by the USDA Soil Survey (see Figure 2-5) as Made Land (Md). Made Land represents fill material that has been added to the site. North of the TCLF site the Paulding soil series occurs, as shown in Figure 2-5. Observed at some boring locations was the former land surface or topsoil horizon that had been covered by the addition of fill material to the site. The location of the buried topsoil is shown in Figure 4-50 and is designated as an organic horizon (ol).

A thin topsoil horizon is developed across the TCLF site. It varies between 0.5 and 3 feet in thickness. Below the topsoil a layer of fill material was encountered during drilling.

Information from Clayton Environmental boring logs was used in conjunction with IRP Stage 2 soil borings installed north of the site to interpret the relationship of the geologic units in that area. Fill material, lacustrine sediments, and till were encountered in the borings at TCLF. These units are displayed in the cross sections presented in Figures 4-50, 451, and 4-52. Figure 4-53 shows the trace of these cross sections.

The site stratigraphy encountered in the soil borings at TCLF generally consisted of layered silt and clay overlying deposits of silty clay to massive clay. A basal deposit of clayey silt, sand, and gravel was observed in these soil borings. This material represents the upper till unit that has been reworked. Across the surface of the site a veneer of black silty topsoil, ranging in thickness from 0.5 to 3 feet, was observed. Below the topsoil to a depth of 5 feet BLS fill material consisting of clay and silt was encountered. A laminated brown and green-gray clay, displaying brown mottling, extended to a depth of 7 to 10 feet BLS. Massive gray clay to silty clay was encountered beneath the mottled clay and extended to the top of the basal silt, sand, and gravel layer.

OVA measurements for soil samples taken from the IRP Stage 2 soil borings at TCLF generally increased with depth. OVA readings from 0 to 10 feet BLS did not exceed the background level of 1 unit. Soil samples from between 10 and 20 feet BLS generally yielded OVA readings below 10 units; however, in some


North A
575
570
565
560
555
550
545
540
Feet Above MSL
CMW#1
CMW#2
05-401
cl fill
ol fill
cl fill
ol
cl gray lam
cl gray massive
cl gray massive
sc till some grave
sc till
sm till
200
300
400
500
600

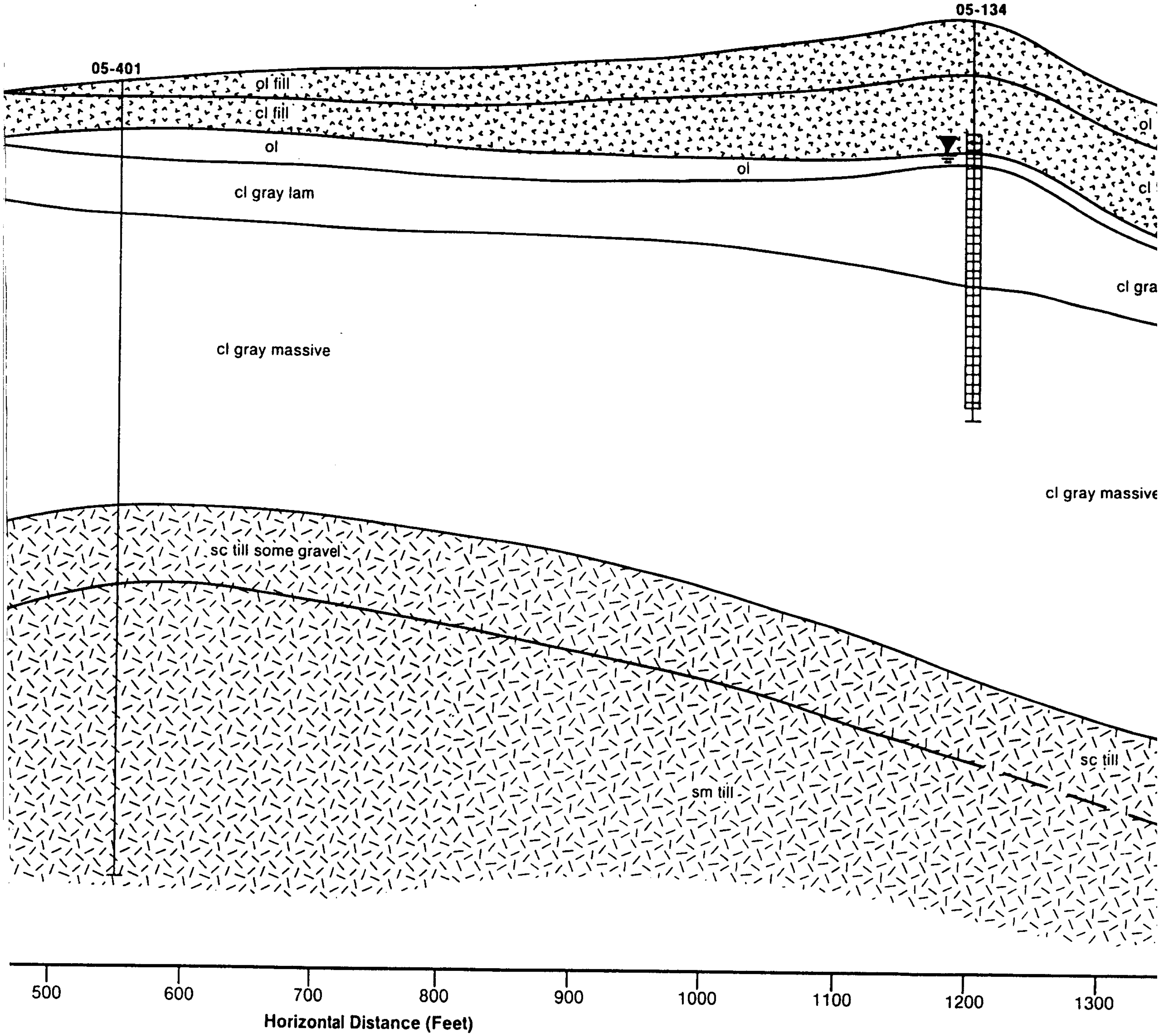

05-401
05-134
ol fill
cl fill
ol
ol
cl gray lam
cl gray massive
cl gra
cl gray massive
sc till some gravel
sc till
sm till
500
600
700
800
900
1000
1100
1200
1300
Horizontal Distance (Feet)

FIGURE 4

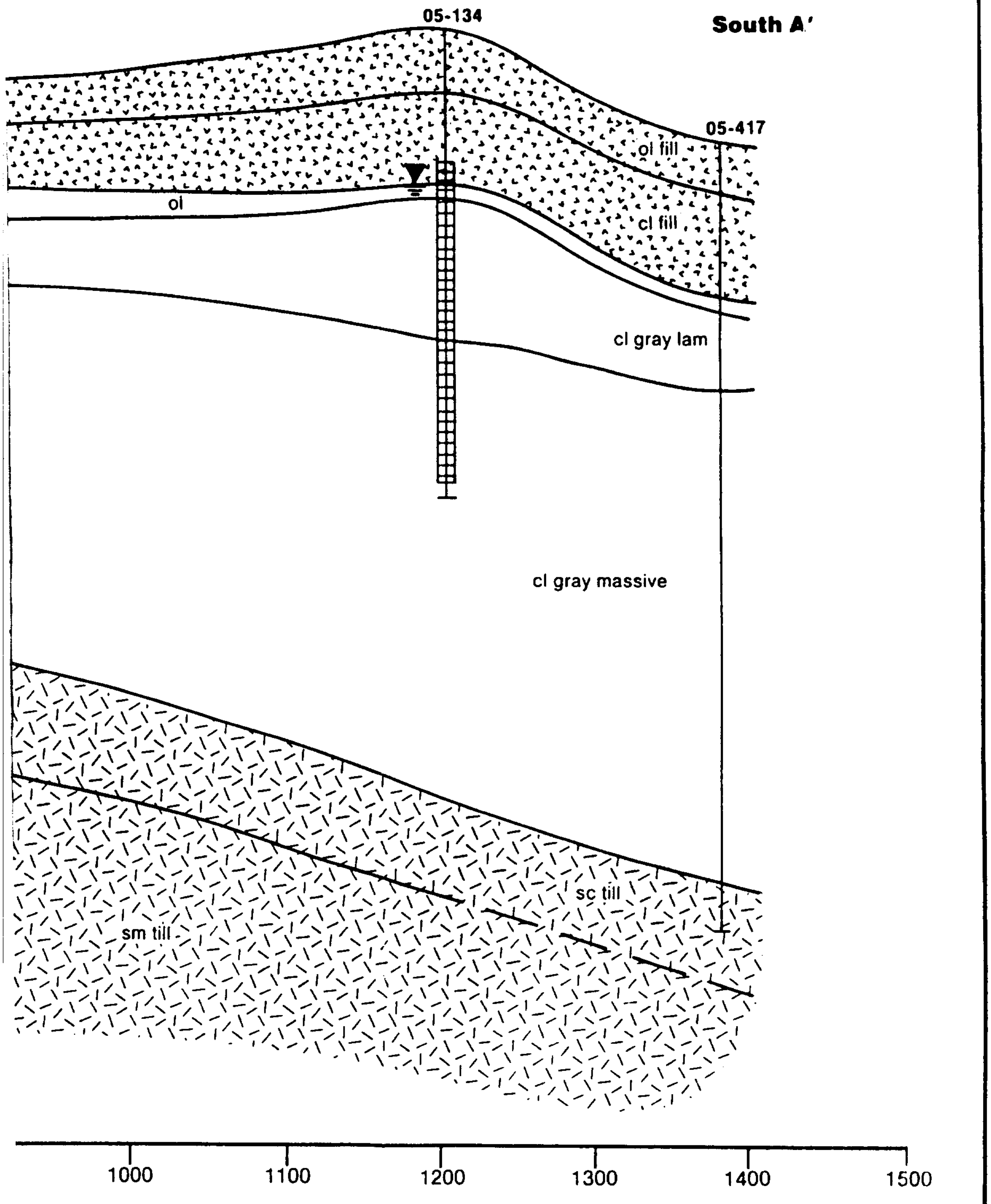
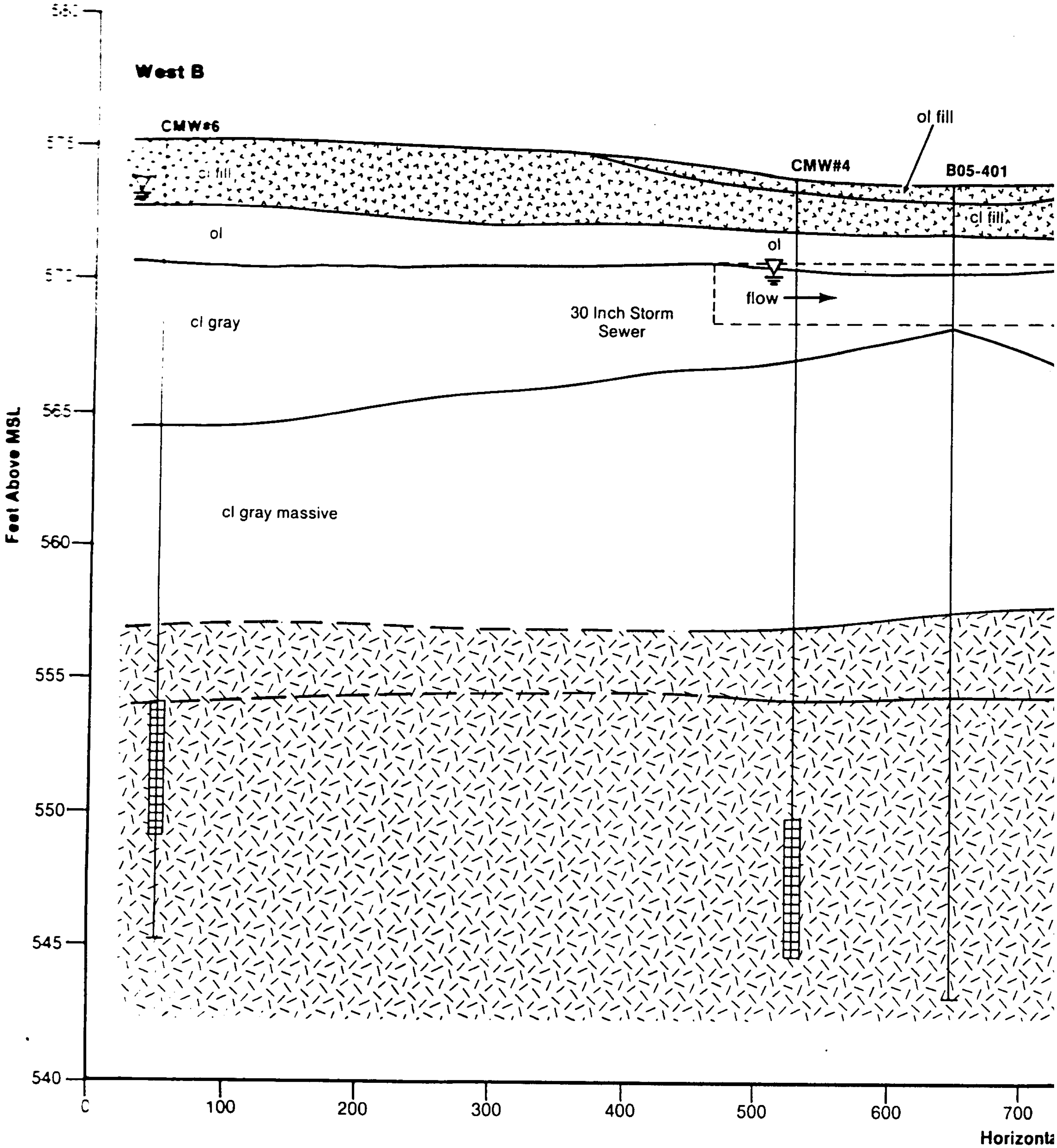
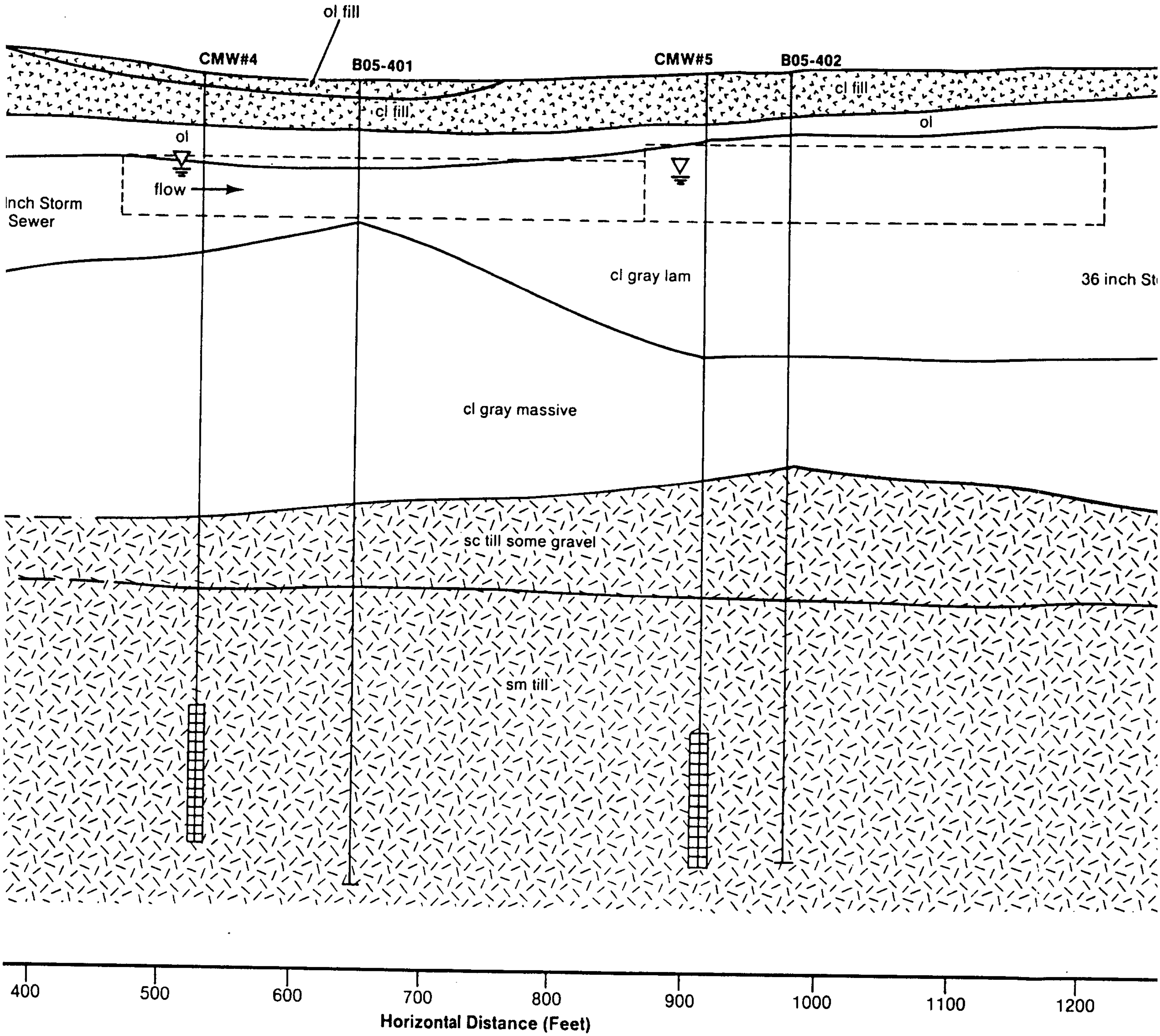


FIGURE 4-50 TCLF GEOLOGIC CROSS SECTION A-A'



West B
CMW#6
CMW#4
B05-401
ol fill
cl fill
ol
ol
cl gray
30 Inch Storm
Sewer
flow
cl gray massive
Feet Above MSL
560
555
550
545
540
0
100
200
300
400
500
600
700
Horizonta



ol fill
CMW#4
B05-401
CMW#5
B05-402
cl fill
cl fill
ol
ol
Inch Storm Sewer
flow
cl gray lam
36 inch St
cl gray massive
sc till some gravel
sm till
400
500
600
700
800
900
1000
1100
1200
Horizontal Distance (Feet)

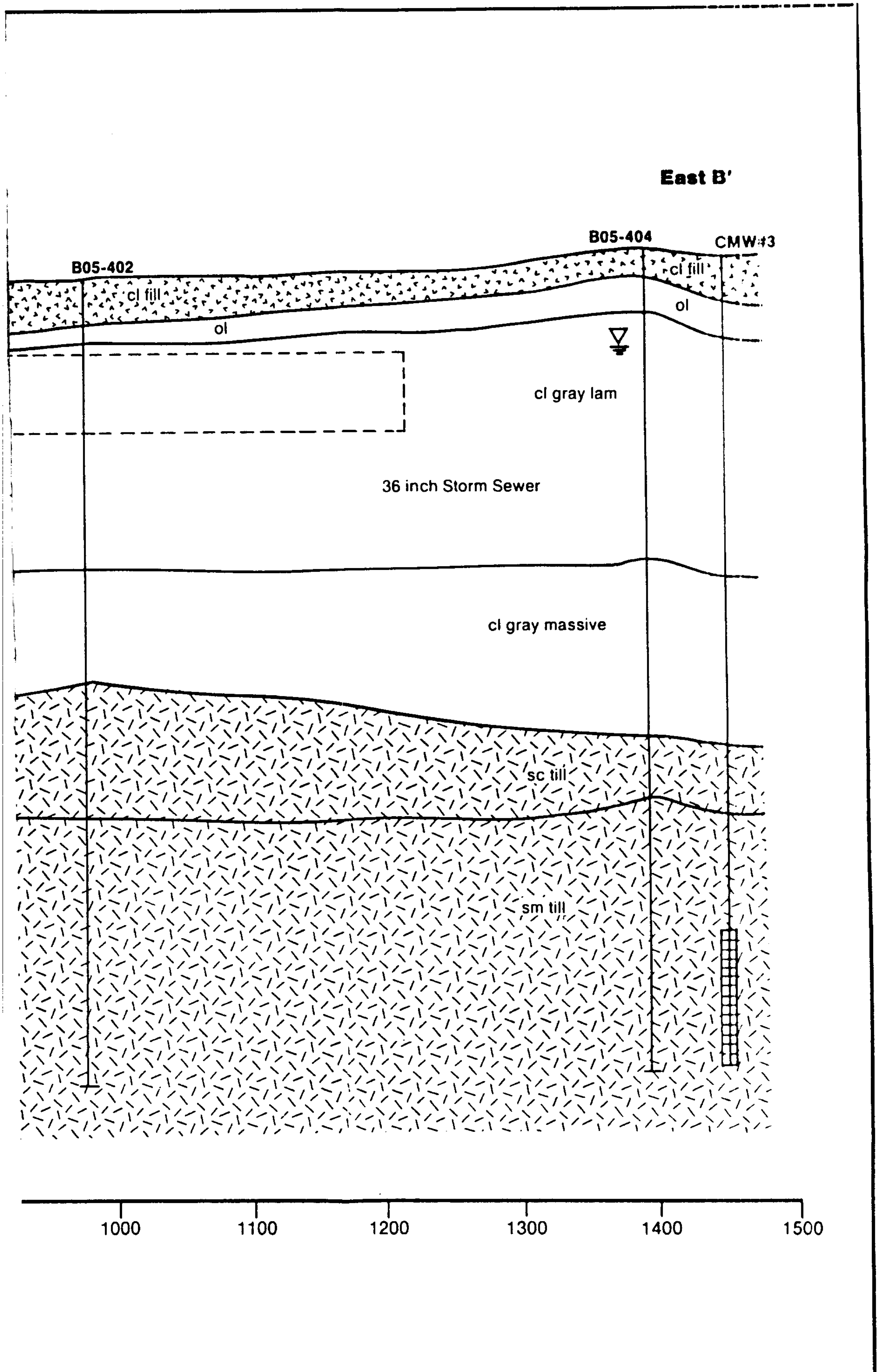
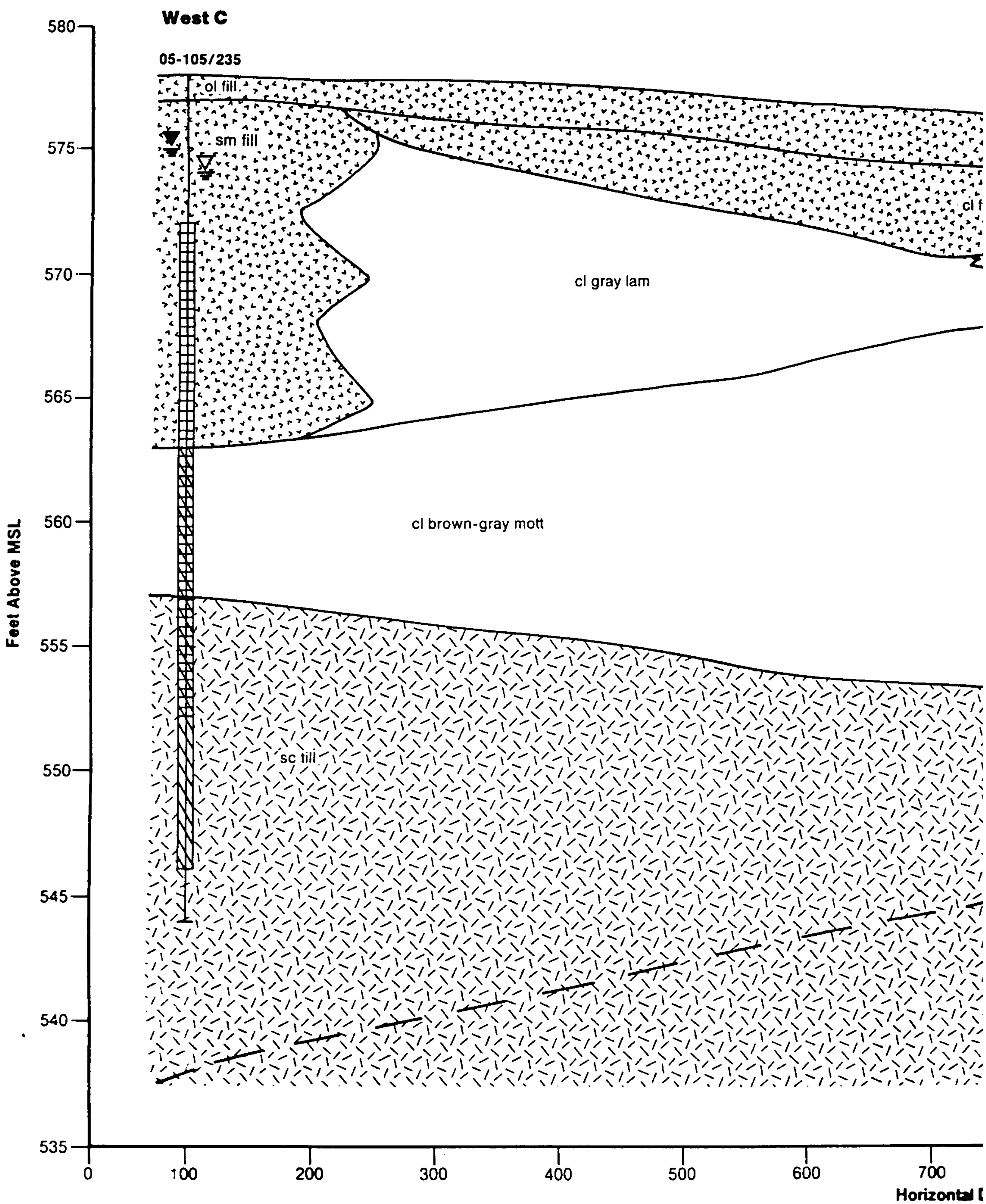
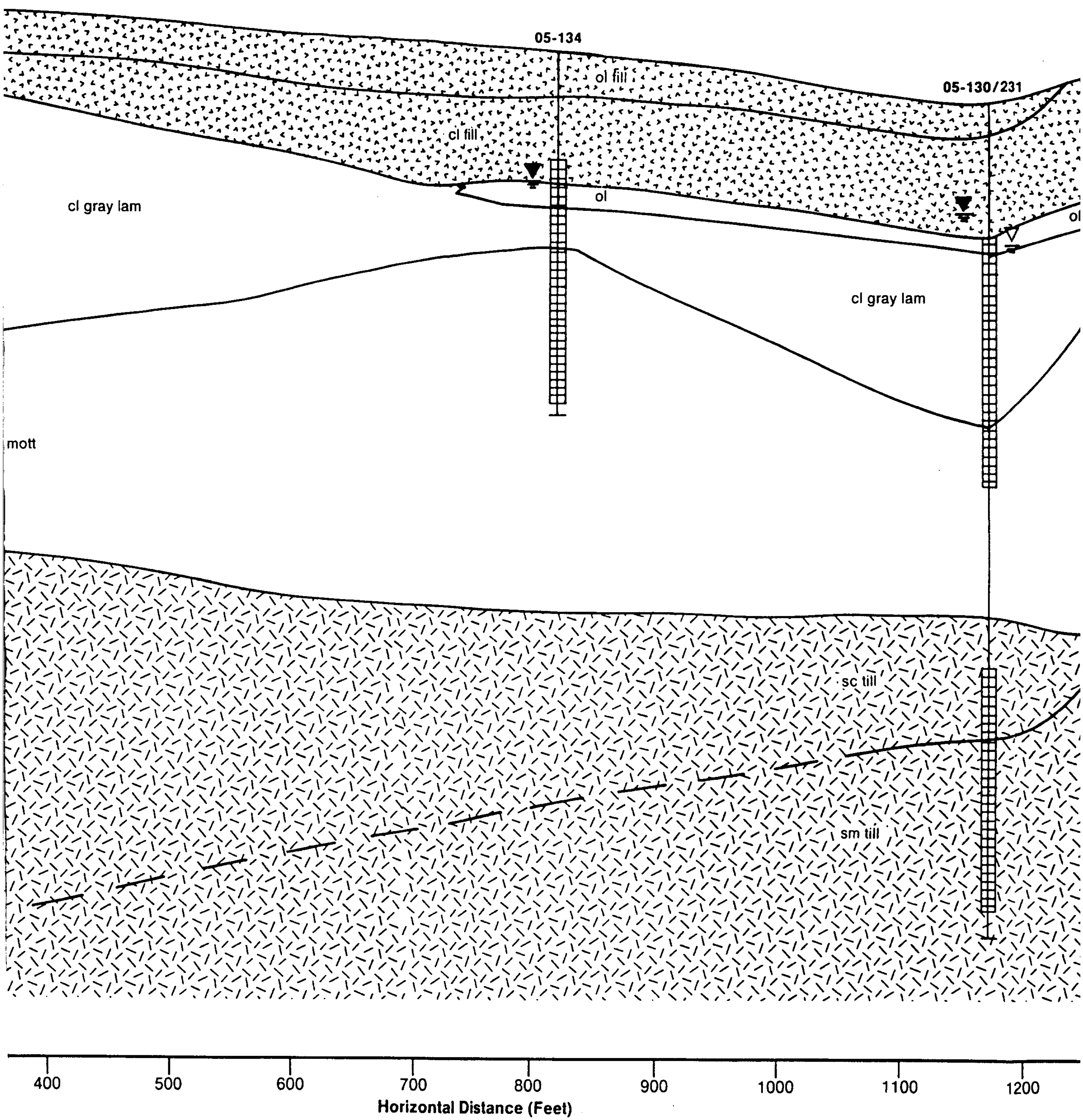


FIGURE 4-51 TCLF GEOLOGIC CROSS SECTION B-B'



West C
05-105/235
ol fill
sm fill
cl fi
cl gray lam
cl brown-gray mott
sc till
Feet Above MSL
580
575
570
565
560
555
550
545
540
535
0
100
200
300
400
500
600
700
Horizontal D



05-134
05-130/231
ol fill
cl fill
ol
cl gray lam
cl gray lam
mott
sc till
sm till
400
500
600
700
800
900
1000
1100
1200
Horizontal Distance (Feet)

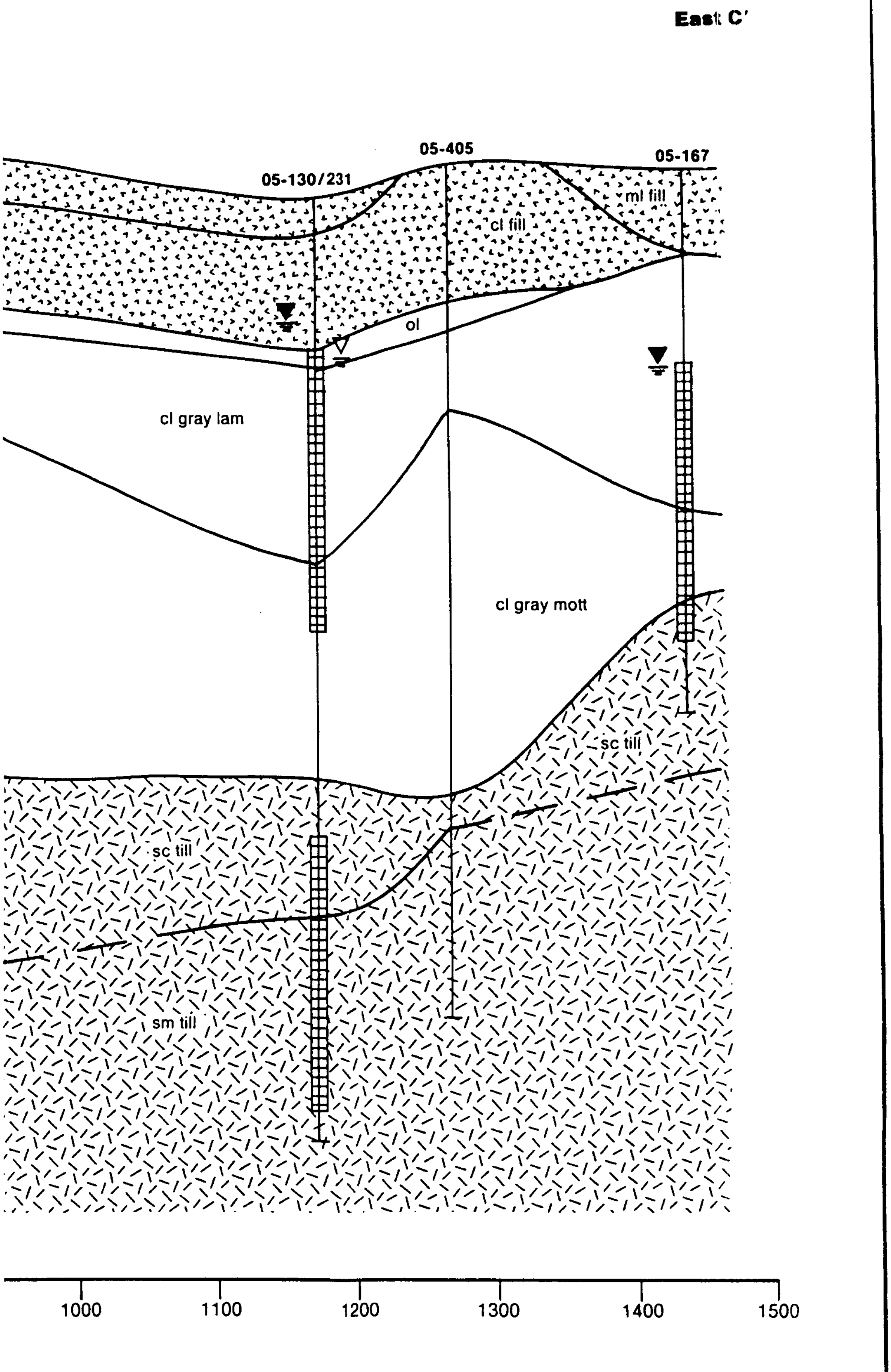
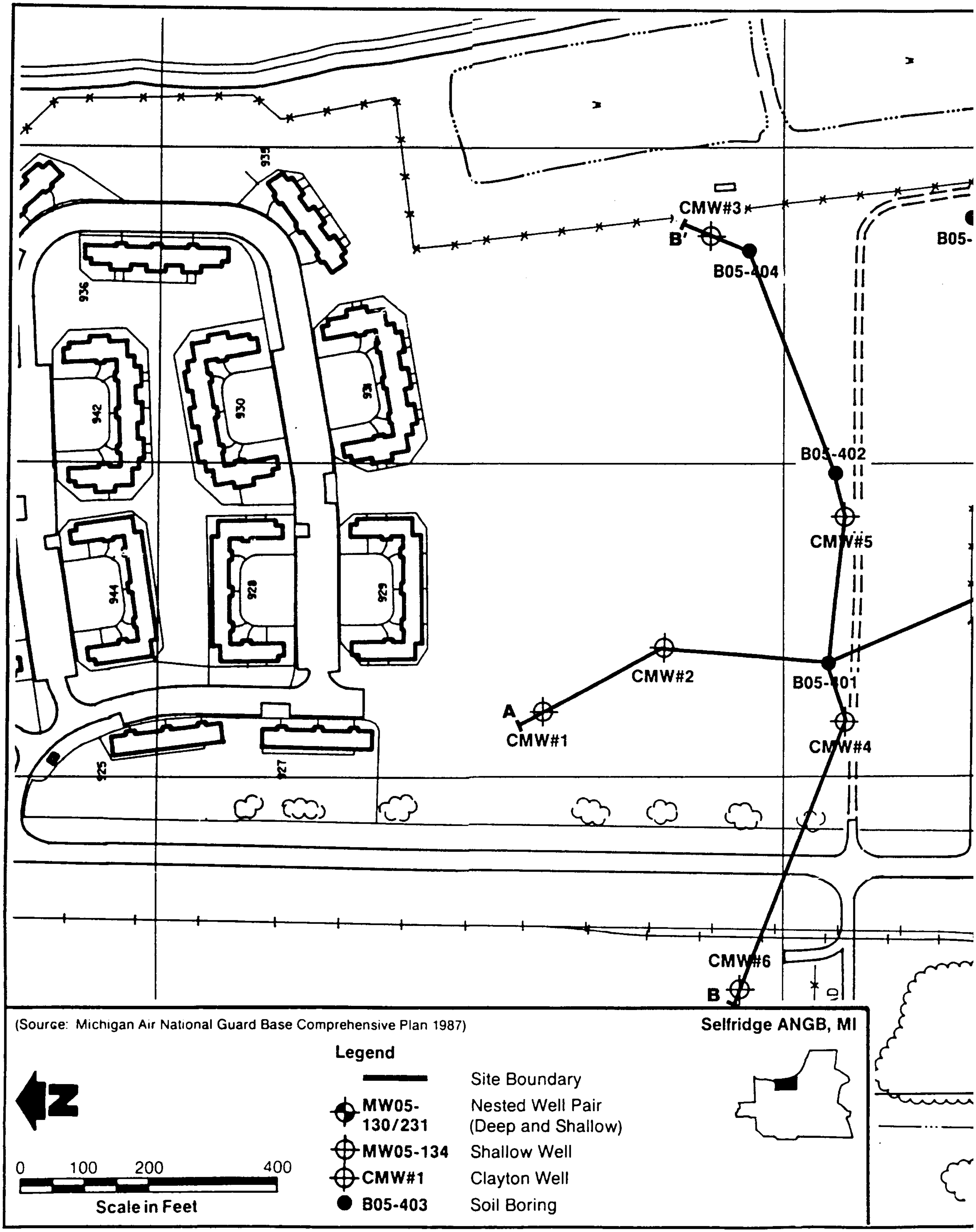
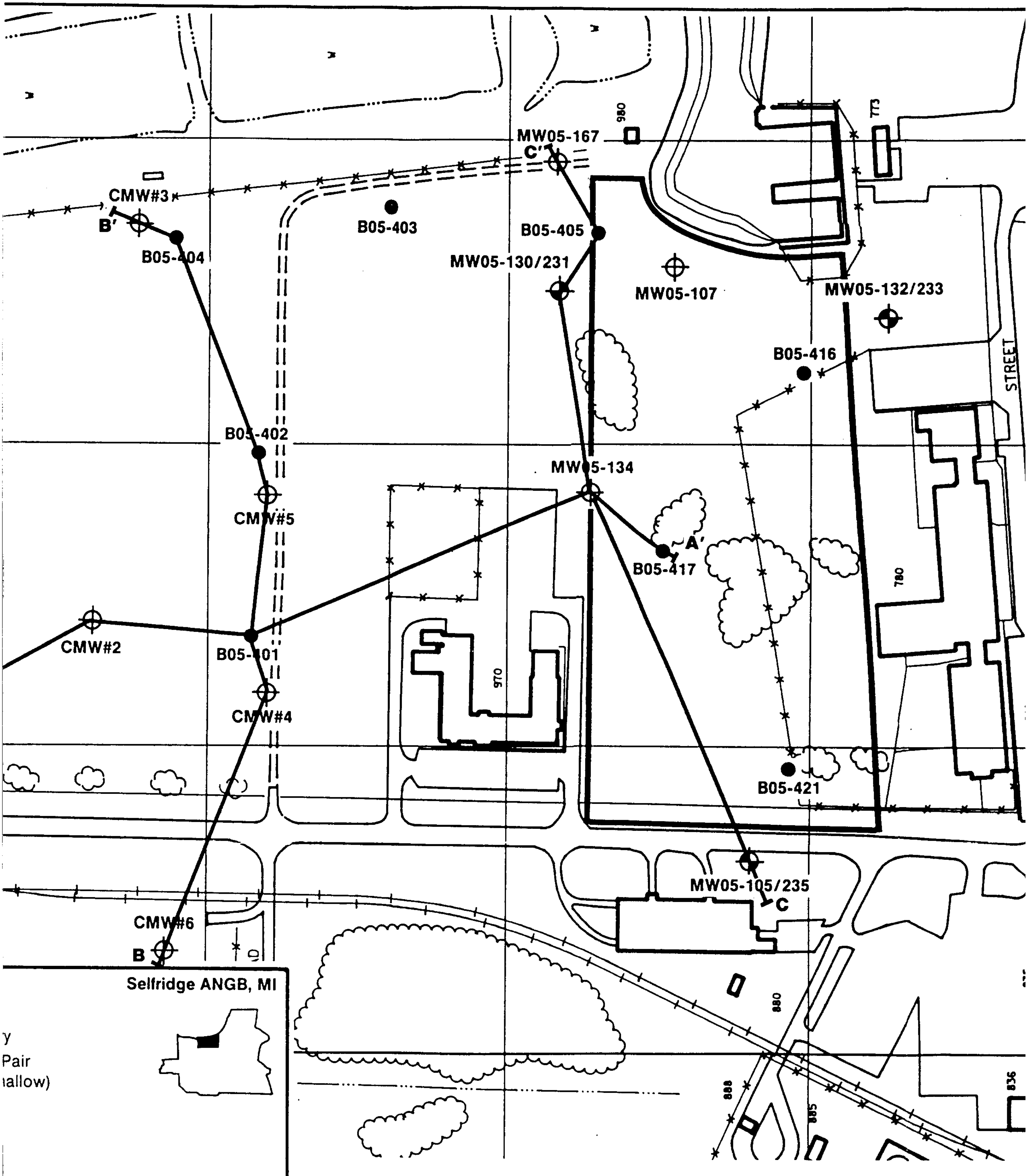


FIGURE 4-52 TCLF GEOLOGIC CROSS SECTION C-C'



CMW#3
B'
B05-404
B05-402
CMW#5
CMW#2
B05-401
CMW#4
A
CMW#1
CMW#6
B
936
935
942
930
931
944
928
929
925
927
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW05-130/231 Nested Well Pair (Deep and Shallow)
MW05-134 Shallow Well
CMW#1 Clayton Well
B05-403 Soil Boring
N
0 100 200 400
Scale in Feet



CMW#3
B'
B05-404
B05-403
MW05-167
C'
980
B05-405
MW05-130/231
MW05-107
MW05-132/233
773
B05-416
STREET
B05-402
CMW#5
MW05-134
A'
B05-417
780
CMW#2
B05-401
970
CMW#4
B05-421
MW05-105/235
C
CMW#6
B
Selfridge ANGB, MI
y
Pair
allow)
880
888
885
836

FIGU

4-26

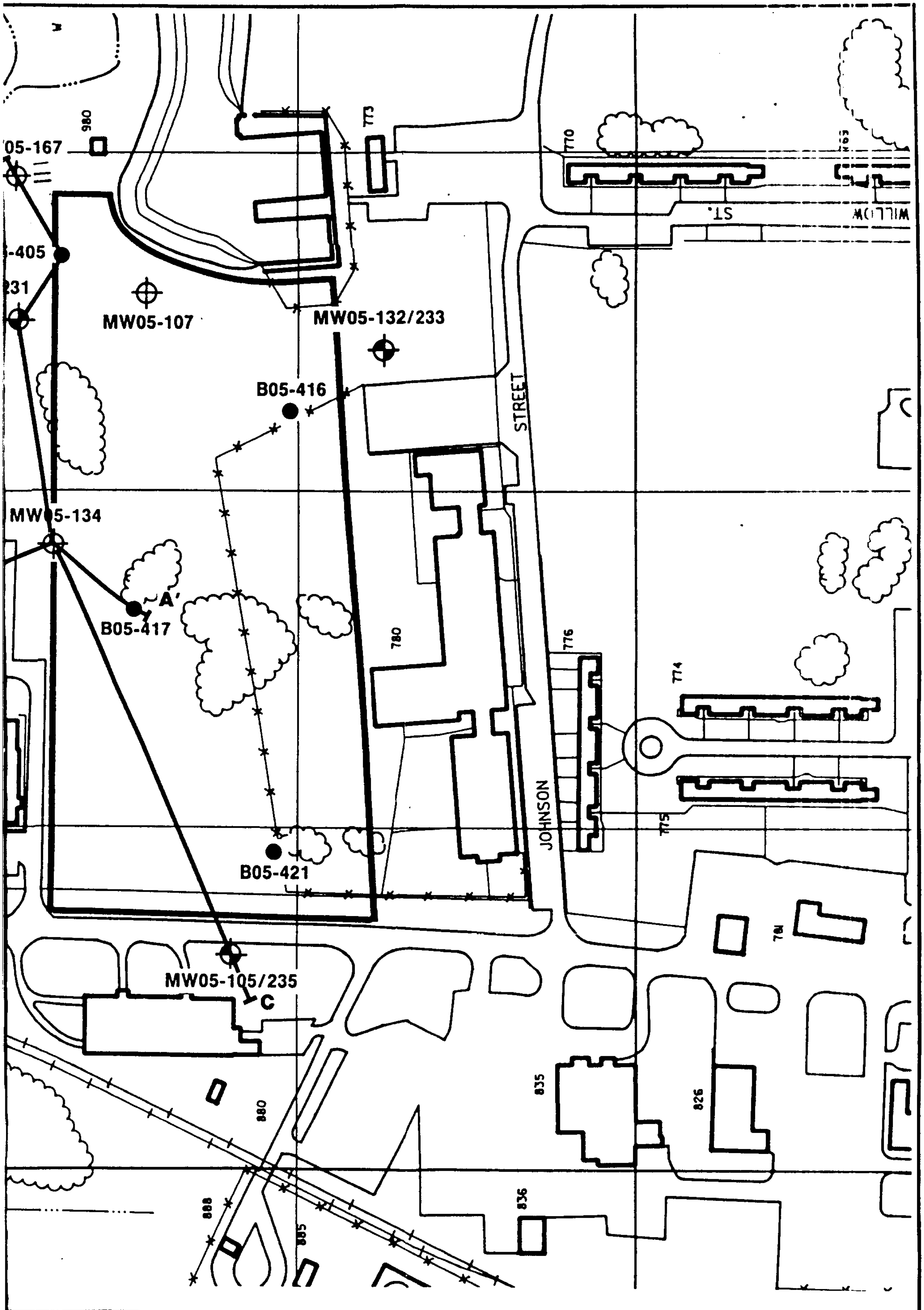


FIGURE 4-53 TRACE OF CROSS SECTIONS A-A', B-B' AND C-C' AT TCLF

soil boreholes, OVA measurements up to 40 units were recorded for this depth interval. The OVA readings from soil samples taken between 20 and 30 feet BLS registered in excess of 100 units at four of the eight soil borings (05-401, 05-403, 05-416, and 05-417). The maximum OVA reading for TCLF was obtained from the 25- to 30-foot soil sample interval from soil boring 05-403. This soil sample interval registered 90 to 550 OVA units. No visible signs of subsurface contamination were observed nor any unusual odors noted during drilling of the TCLF soil borings.

Four shallow and three deep groundwater monitor wells were installed at TCLF. Shallow monitor wells were screened in laminated, iron-stained, mottled, silty clay and gray clay. The deep monitor wells were screened predominantly in gray sandy clay to clayey sand. The lower till unit, consisting of a dense silt, sand, and gravel layer, was penetrated by monitor well borings 05-231 and 05-233.

The maximum OVA readings for soil samples taken from the groundwater monitor well borings at TCLF were obtained from monitor well boring 05-235. The highest OVA measurement obtained in this monitor well boring was 300 to 400 units for the 5- to 10-foot soil sample core. Soil samples below 10 feet in the two other deep monitor well borings at the site, 05-231 and 05-233, registered OVA readings above background level, but below 10 units. All soil samples extracted from shallow monitor well borings 05-130 and 05-134 registered below background level. The 10- to 15-foot and 15- to 20-foot soil cores from shallow replacement monitor well 05-167 had OVA readings from 1 to 2 and 3 to 6 units, respectively. There were no visible signs of contamination observed nor any unusual odors noted during drilling of the groundwater monitor well borings at TCLF.

4.8.1.2 Extent and Character of Unsaturated Zone -- TCLF

The unsaturated zone is predominantly comprised of the fill material. The fill material was comprised of silt and clay with minor amounts of soil and gravel. Pieces of asphalt, cement, and coal were also found in the fill material. Fill material thickness ranged from approximately 1 to 15 feet. The thickest fill material was encountered at the location of monitor well 05-235. Fill material at this location represents material added to the area during construction of Jefferson Street, which is located immediately adjacent to this monitor well boring.

The unsaturated zone at TCLF extended to a depth of 7 to 13 feet BLS. The boundary between the unsaturated and saturated zone was determined based upon relative moisture content and mottling of the sediments. Brown, iron-stained mottling was observed in the unsaturated zone. The sediments have a gray mottling in the saturated zone. Dry to moist conditions were encountered in the vadose zone.

The locations of some of the stormwater drainage network at TCLF are shown in Figure 4-51. These drainage pipes are located in the lower part of the unsaturated zone and the upper part of the saturated zone. Figure 3-16 shows the location and extent of the drainage network at TCLF.

4.8.1.3 Groundwater Conditions -- TCLF

During drilling at TCLF the top of the saturated zone was encountered between the depths of 7 and 13 feet BLS. A change from brown, iron-stained mottling to gray mottling and increased moisture content was used to define the top of the saturated zone. Saturated sediment was observed at this boundary. Following installation of the monitor wells the water levels in the monitor wells rose above the initial levels of sediment saturation observed during installation of the borings.

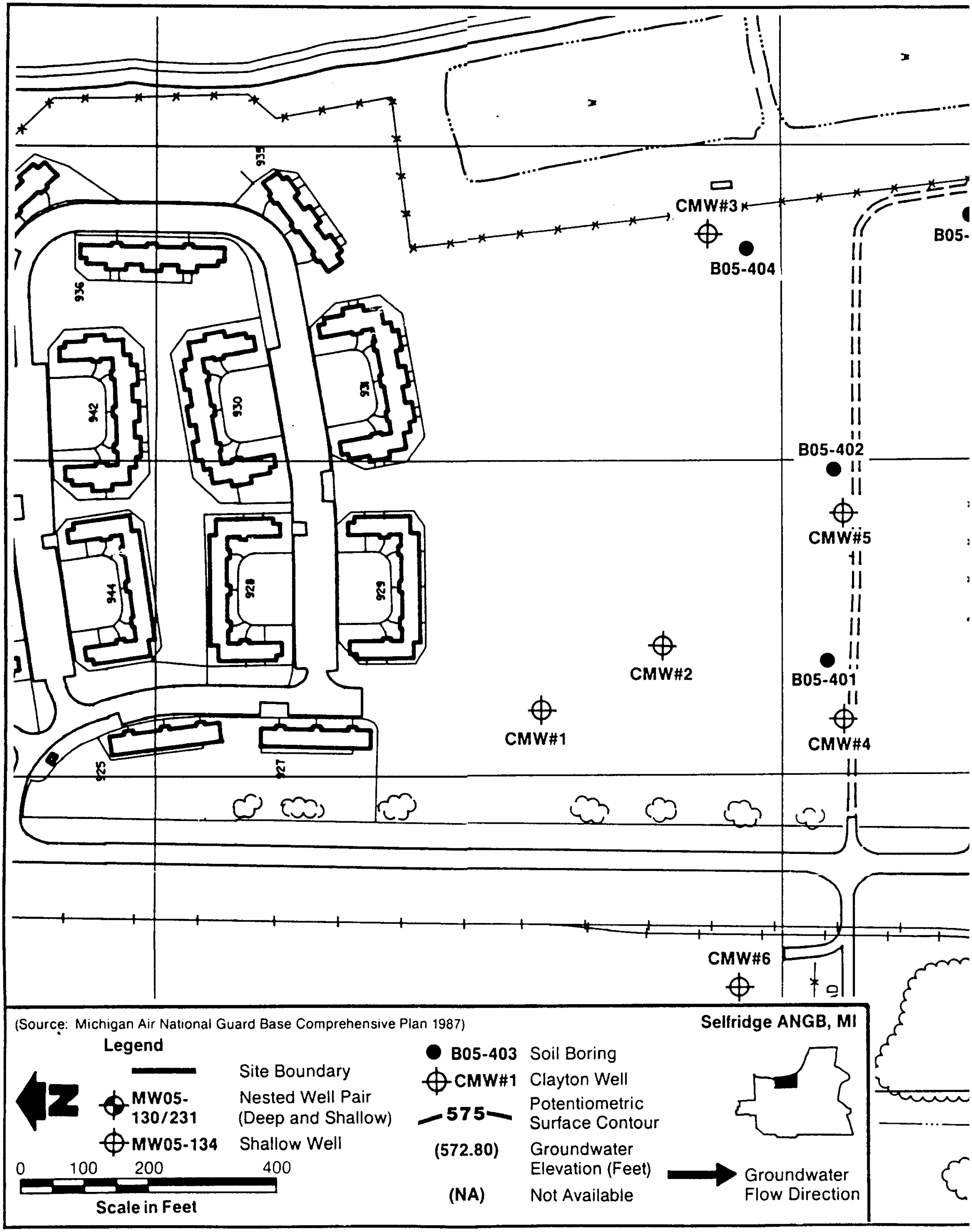
Seven rounds of water level measurements were collected from the monitor wells during this IRP study. Six monitor wells previously installed by Clayton Environmental were only accessible during June and August 1988 for measurement of water levels. Water level measurements were used to construct potentiometric surface maps for a measurement period. Measurement of water levels in the Clayton Environmental monitor wells allowed for a more complete determination of the potentiometric surface north of the site.

Prior to 21 March 1988 monitor well water levels had not reached equilibrium following their installation. Well development and groundwater pumping created non-equilibrium conditions between 21 March and 1 August 1988. The potentiometric maps for 21 March and 1 August 1988 show near-equilibrium water level conditions.

Figure 4-54 presents the potentiometric surface map for shallow monitor wells on 21 March 1988. Groundwater flow, based upon this map, is generally to the east across the site. Along the shoreline of Lake St. Clair groundwater flow is westward, away from the lake and toward the site. A groundwater sink exists at the location of monitor well 05-167. The presence of the sink is attributed to infiltration of groundwater into the stormwater drainage system. The magnitude and depth of the sink may be caused by low permeability conditions that are indicated by the slow recharge observed in the monitor well during development and sampling.

The potentiometric surface map for the deep monitor wells on 21 March 1988 is shown in Figure 4-55. Groundwater flow, based upon this map, is generally toward the east, but flow is westward along the shoreline.

The shallow monitor well potentiometric surface map for 1 August 1988 is shown in Figure 4-56. Groundwater flow is generally to


CMW#3
B05-404
935
936
942
930
931
944
928
929
925
927
B05-402
CMW#5
CMW#2
B05-401
CMW#1
CMW#4
CMW#6
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW05-130/231 Nested Well Pair (Deep and Shallow)
MW05-134 Shallow Well
B05-403 Soil Boring
CMW#1 Clayton Well
575 Potentiometric Surface Contour
(572.80) Groundwater Elevation (Feet)
(NA) Not Available
Groundwater Flow Direction
0 100 200 400
Scale in Feet

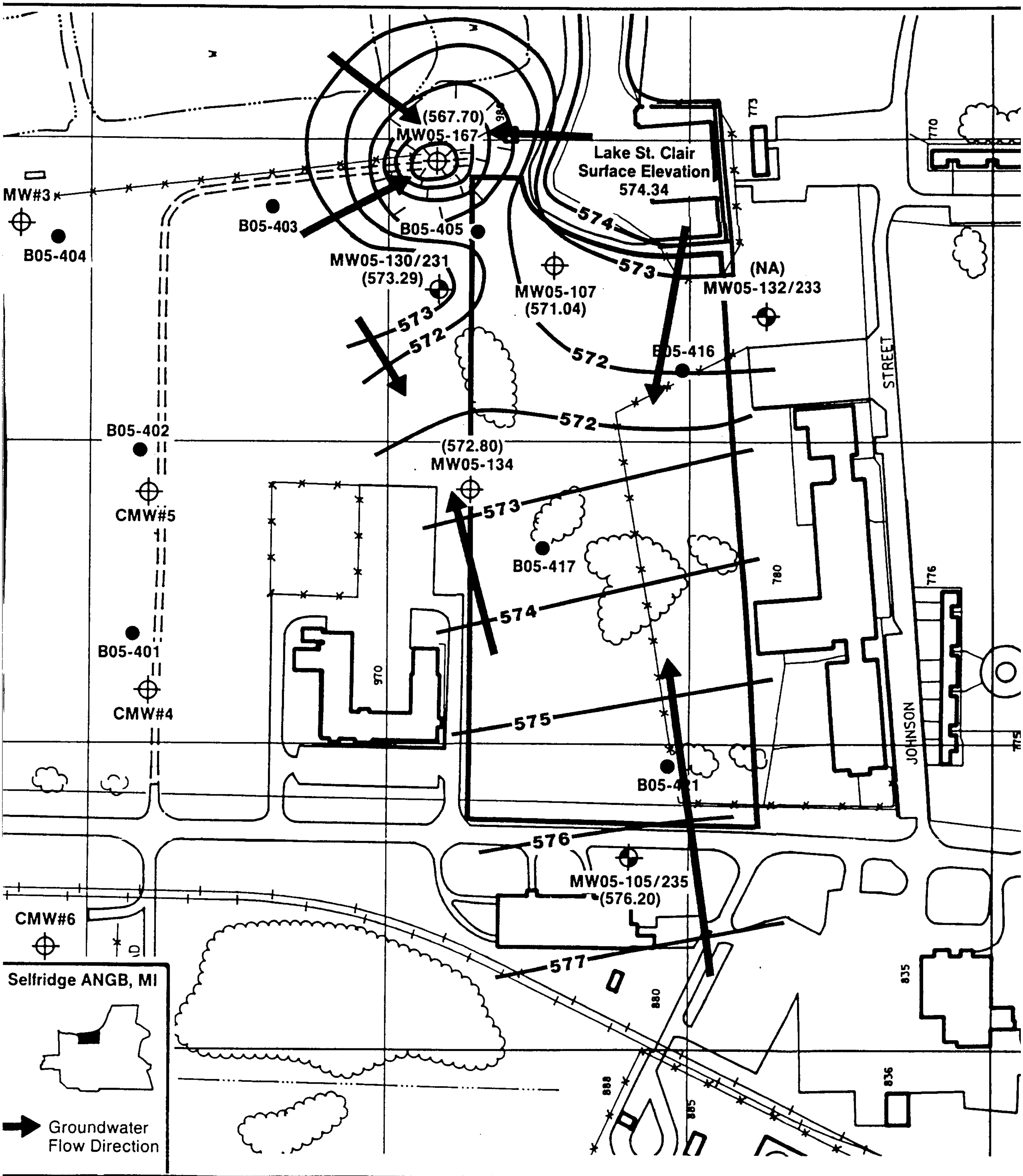


FIGURE 4-54 TCLF POTE
MAP FOR S
ON 21 MAR

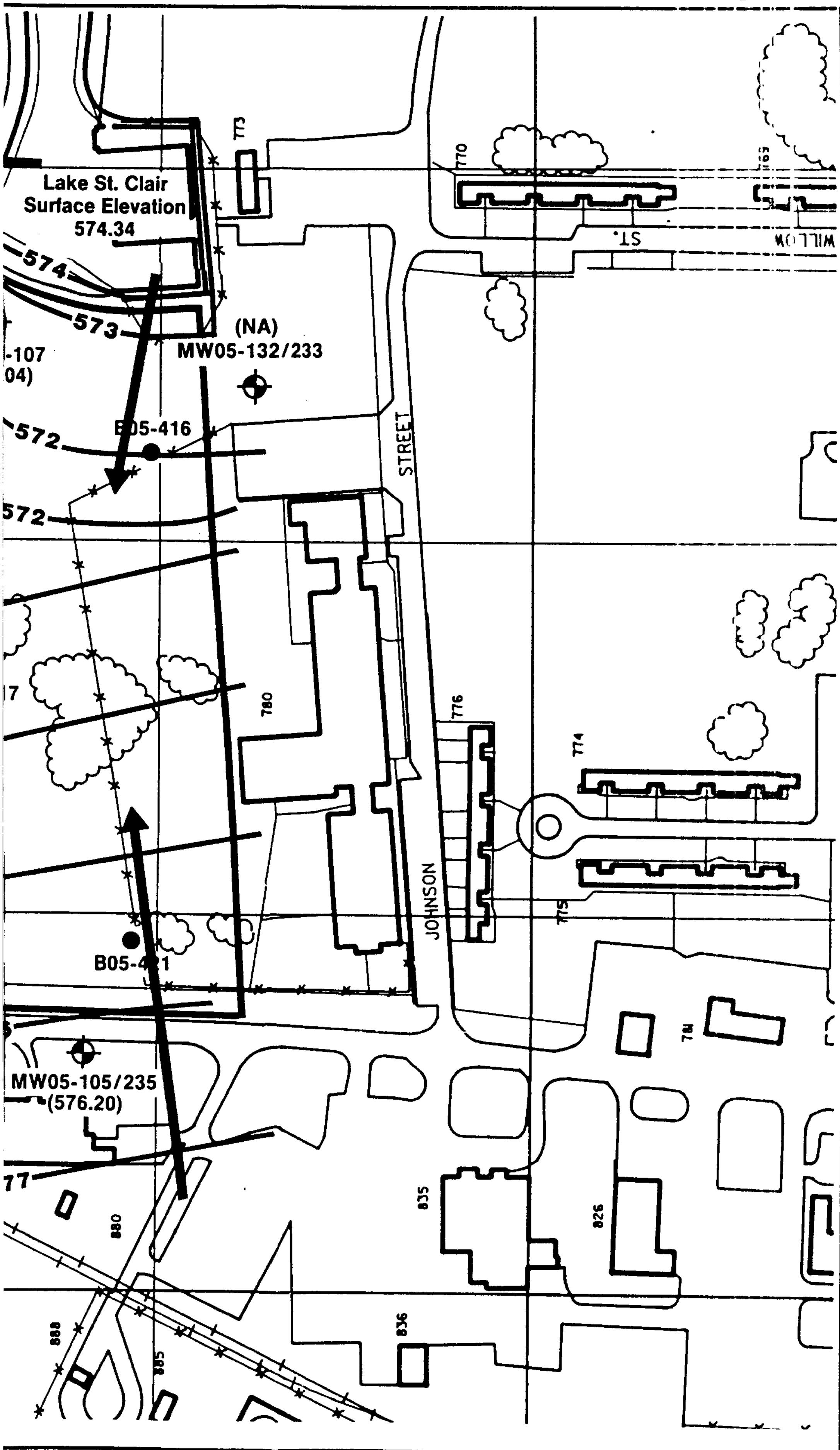
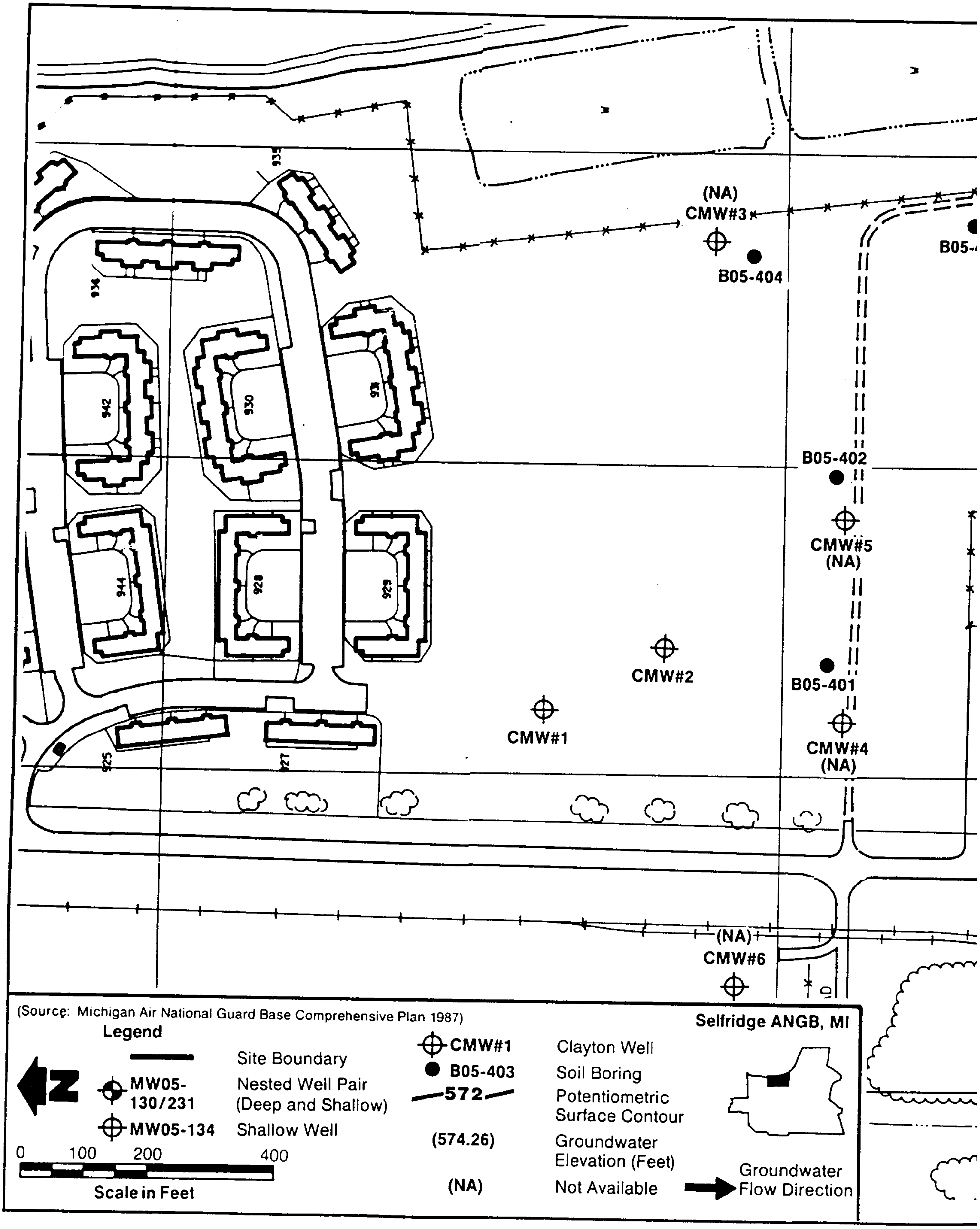


FIGURE 4-54 TCLF POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 21 MARCH 1988



935
934
942
930
931
944
928
929
925
927
(NA)
CMW#3
B05-404
B05-
B05-402
CMW#5
(NA)
CMW#2
B05-401
CMW#1
CMW#4
(NA)
(NA)
CMW#6
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
N
Site Boundary
MW05-130/231
Nested Well Pair (Deep and Shallow)
MW05-134
Shallow Well
0
100
200
400
Scale in Feet
CMW#1
Clayton Well
B05-403
Soil Boring
572
Potentiometric Surface Contour
(574.26)
Groundwater Elevation (Feet)
(NA)
Not Available
Groundwater Flow Direction

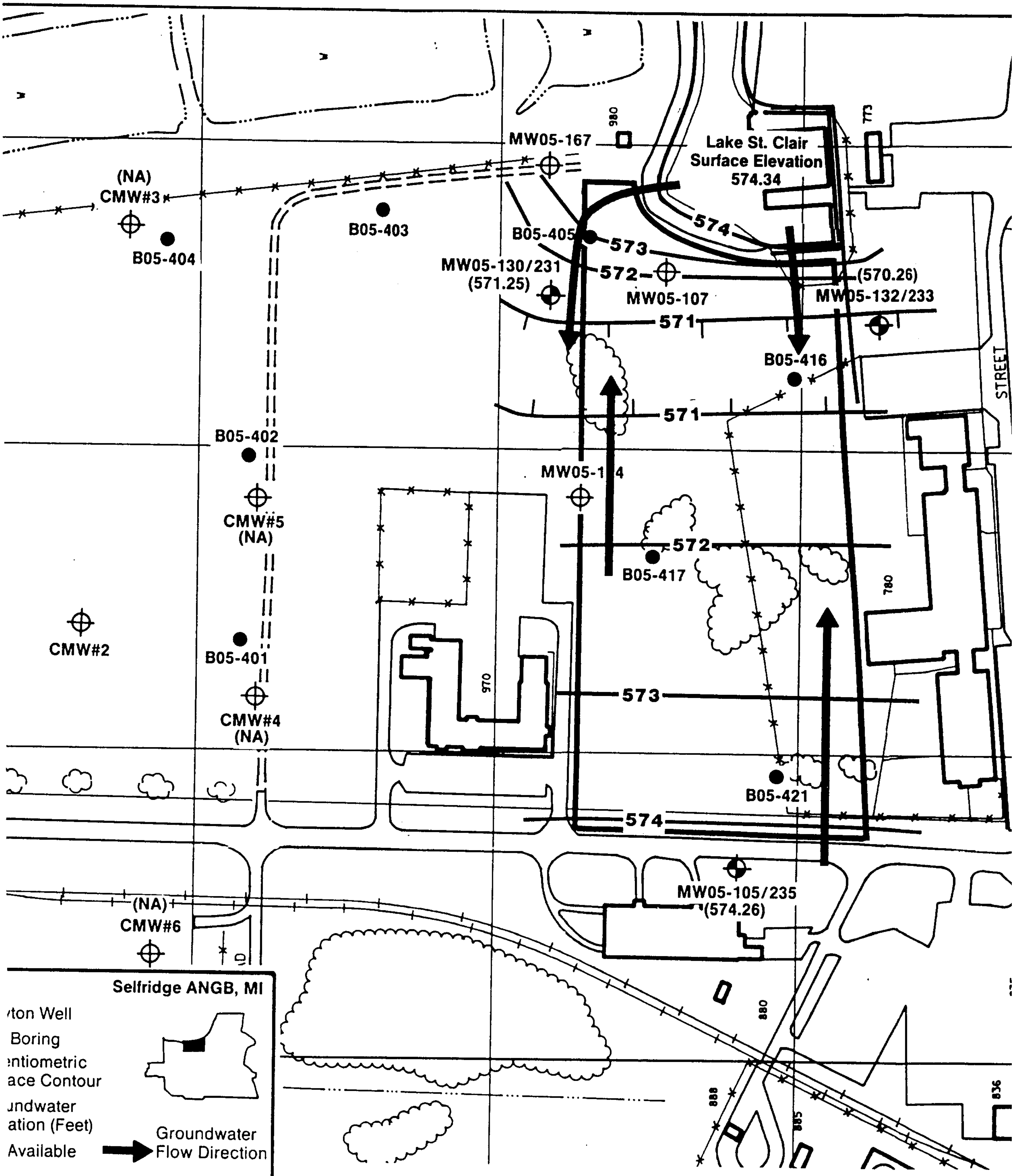

MW05-167
980
Lake St. Clair
Surface Elevation
574.34
773
(NA)
CMW#3
B05-403
B05-404
B05-405
574
573
MW05-130/231
(571.25)
572
MW05-107
(570.26)
MW05-132/233
571
B05-416
STREET
571
B05-402
MW05-1 4
CMW#5
(NA)
572
B05-417
780
CMW#2
B05-401
970
573
CMW#4
(NA)
B05-421
574
MW05-105/235
(574.26)
(NA)
CMW#6
880
888
885
836
Selfridge ANGB, MI
ton Well
Boring
ntiometric
ace Contour
ndwater
ation (Feet)
Available
Groundwater
Flow Direction

FIGURE 4

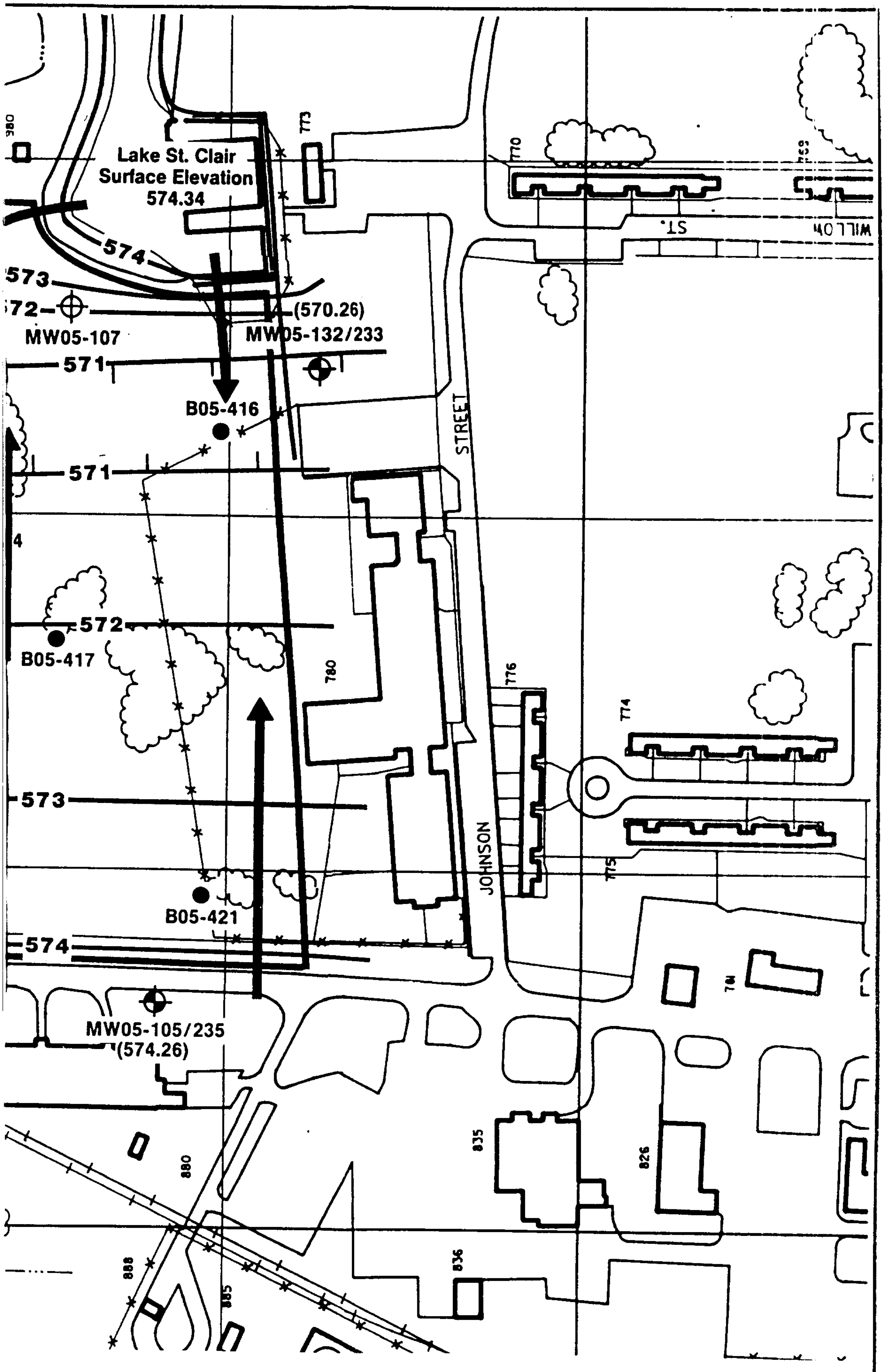
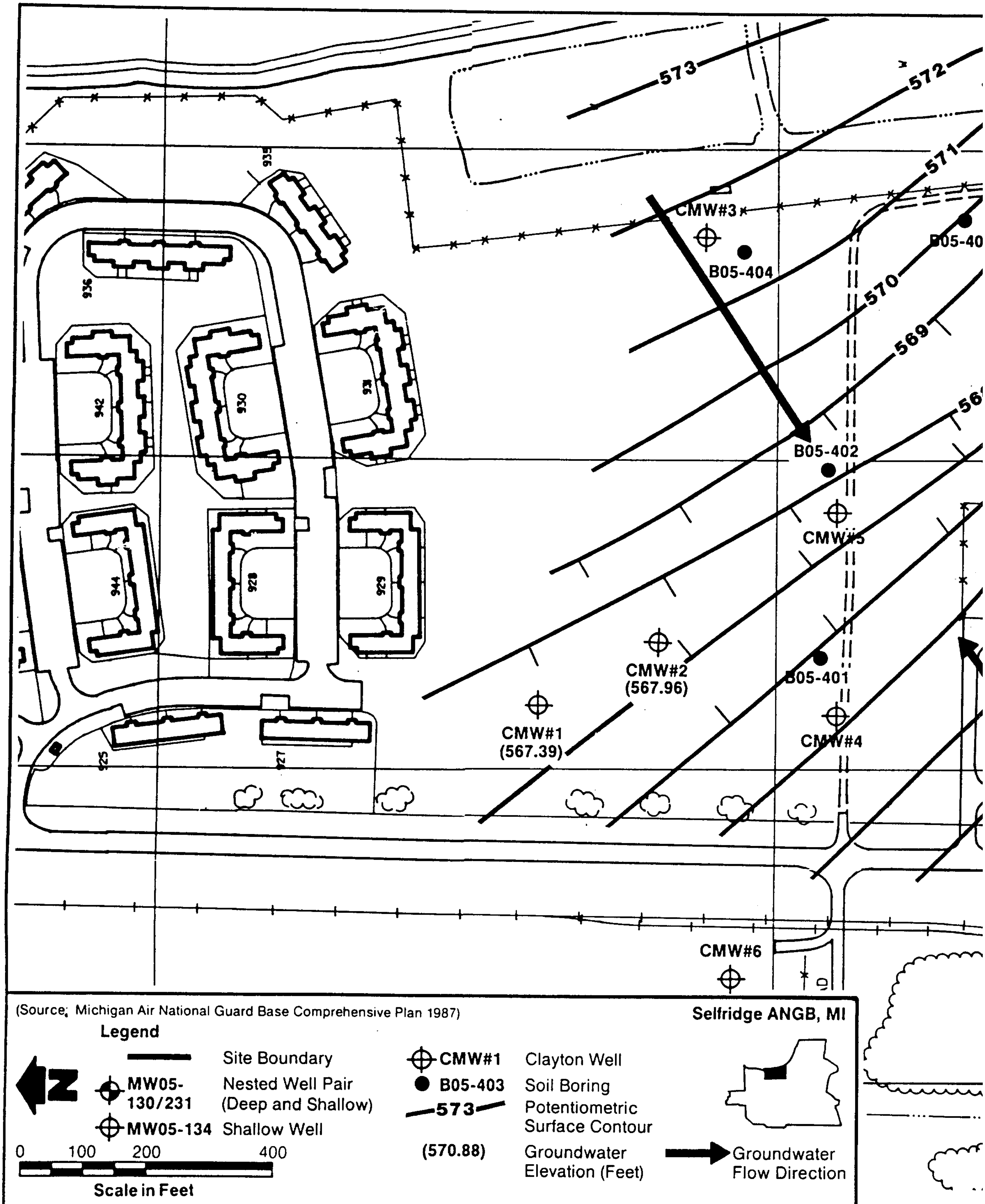


FIGURE 4-55 TCLF POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 21 MARCH 1988



573
572
571
570
569
CMW#3
B05-404
B05-40
B05-402
CMW#5
CMW#2
(567.96)
B05-401
CMW#1
(567.39)
CMW#4
CMW#6
935
936
942
930
931
944
928
929
925
927
(Source; Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
N
MW05-130/231
Nested Well Pair (Deep and Shallow)
MW05-134
Shallow Well
CMW#1
Clayton Well
B05-403
Soil Boring
573
Potentiometric Surface Contour
(570.88)
Groundwater Elevation (Feet)
Groundwater Flow Direction
0
100
200
400
Scale in Feet

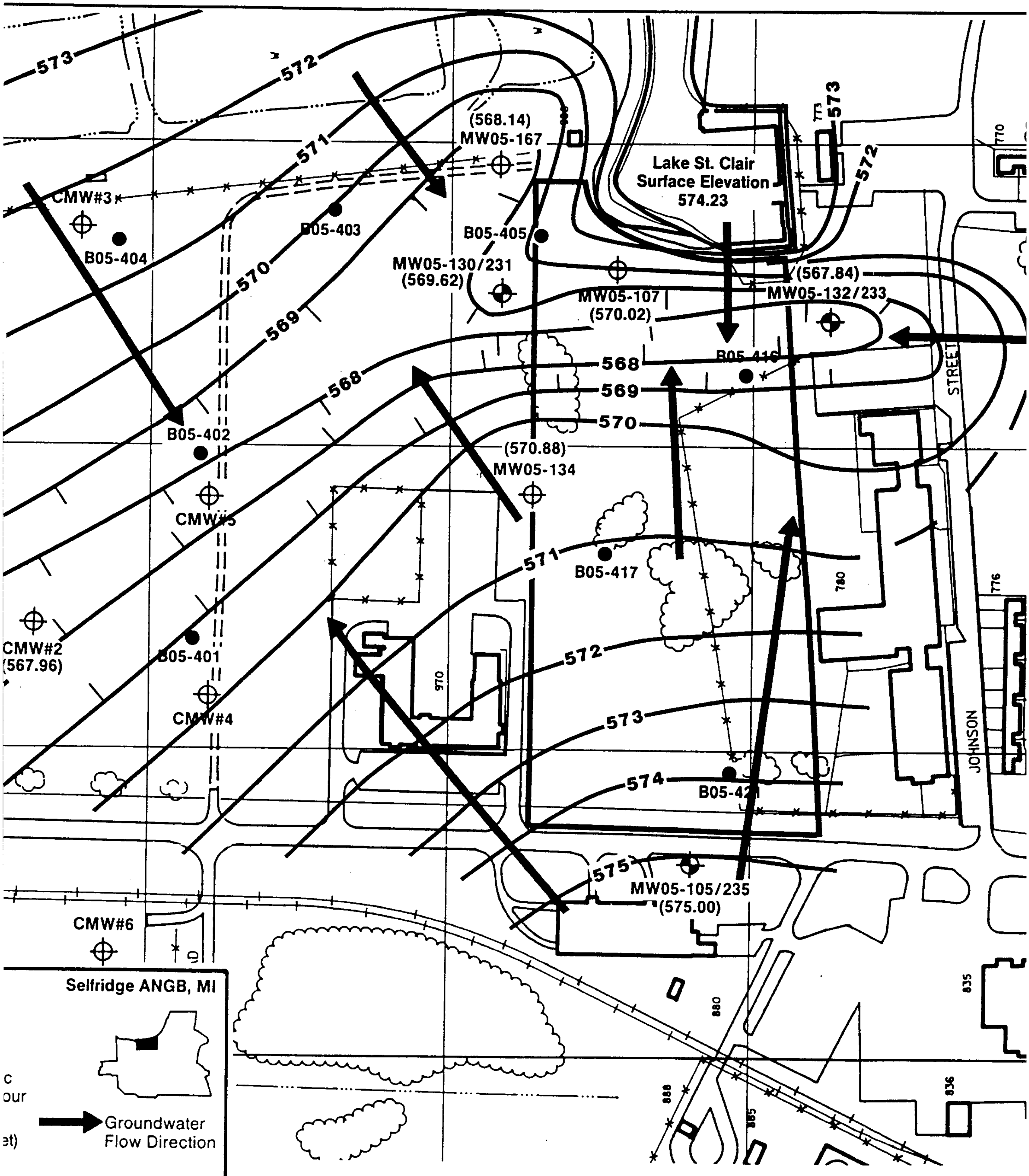


FIGURE 4-56 TCL
MAI
ON

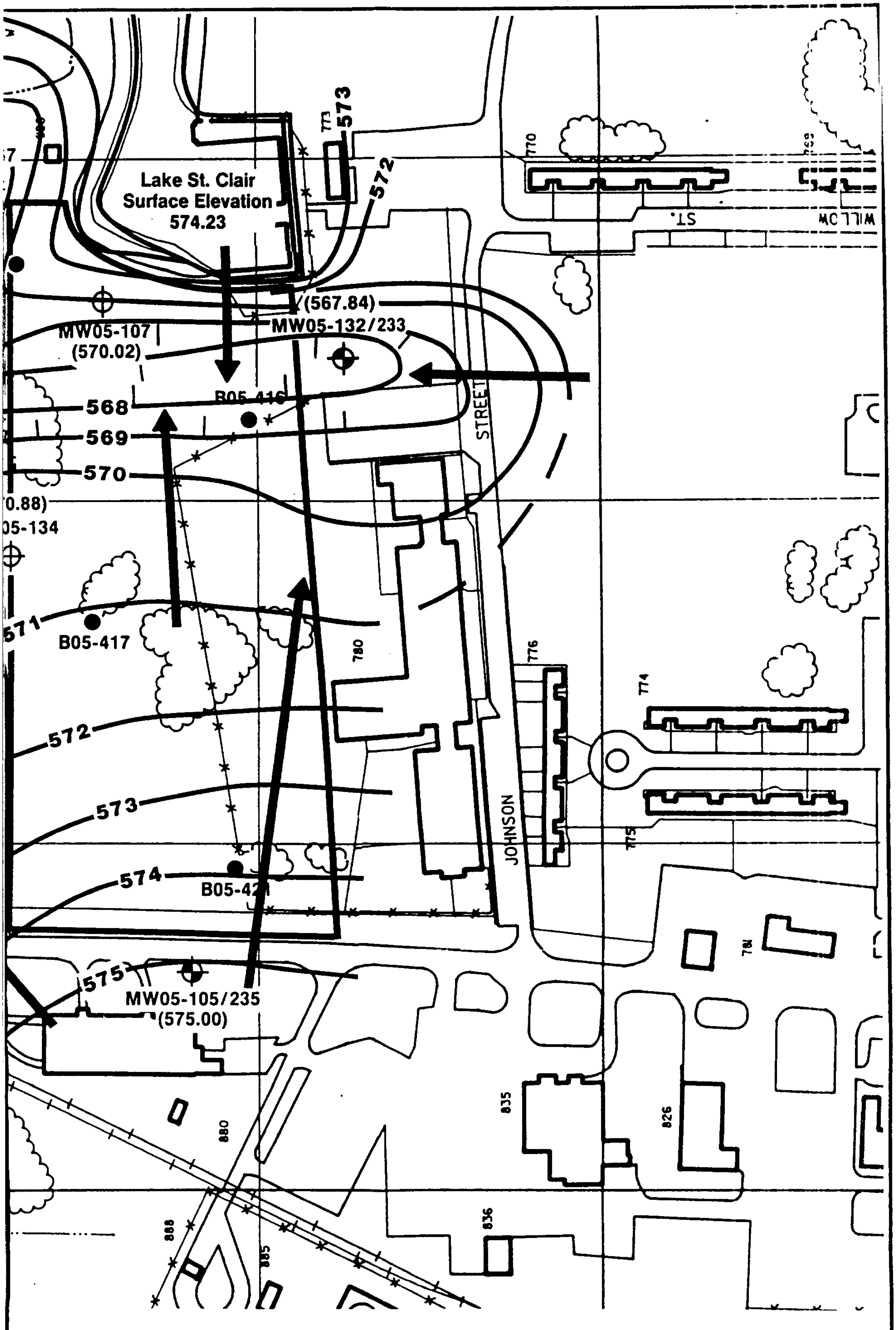


FIGURE 4-56 TCLF POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 1 AUGUST 1988

the east, but along the shoreline, flow is westward, as on 21 March 1988.

Figure 4-57 is the potentiometric surface map for the deep monitor wells on 1 August 1988. Along the western side of the site groundwater flow is toward the east. Groundwater flow along the shoreline is toward the west into the site. A groundwater sink exists in an area from monitor well 05-233 north to monitor well 05-231, based upon the map.

Average site gradients were calculated based upon each of the potentiometric surface maps. For the 21 March 1988 shallow monitor well potentiometric map the gradient was 0.005 ft/ft. The gradient on 1 August 1988 was 0.008 ft/ft. The gradient of the potentiometric surface on 21 March 1988 for deep monitor wells was 0.003 ft/ft and on 1 August 1988 was 0.004 ft/ft.

The hydraulic conductivity values determined for the monitor wells at TCLF are shown in Table 3-18. The average hydraulic conductivity for all monitor wells was calculated to be 8.40×10^{-7} ft/sec (2.56×10^{-5} cm/sec). The average hydraulic conductivity for the shallow monitor wells (05-105, 05-107, 05-130, 05-132, 05-134, and 05-167) was 1.08×10^{-6} ft/sec (3.30×10^{-5} cm/sec). The deep monitor wells (05-231, 05-233, and 05-235) average hydraulic conductivity was 3.51×10^{-7} ft/sec (1.07×10^{-5} cm/sec). Hydraulic conductivities were not determined for the Clayton Environmental monitor wells located north of the site.

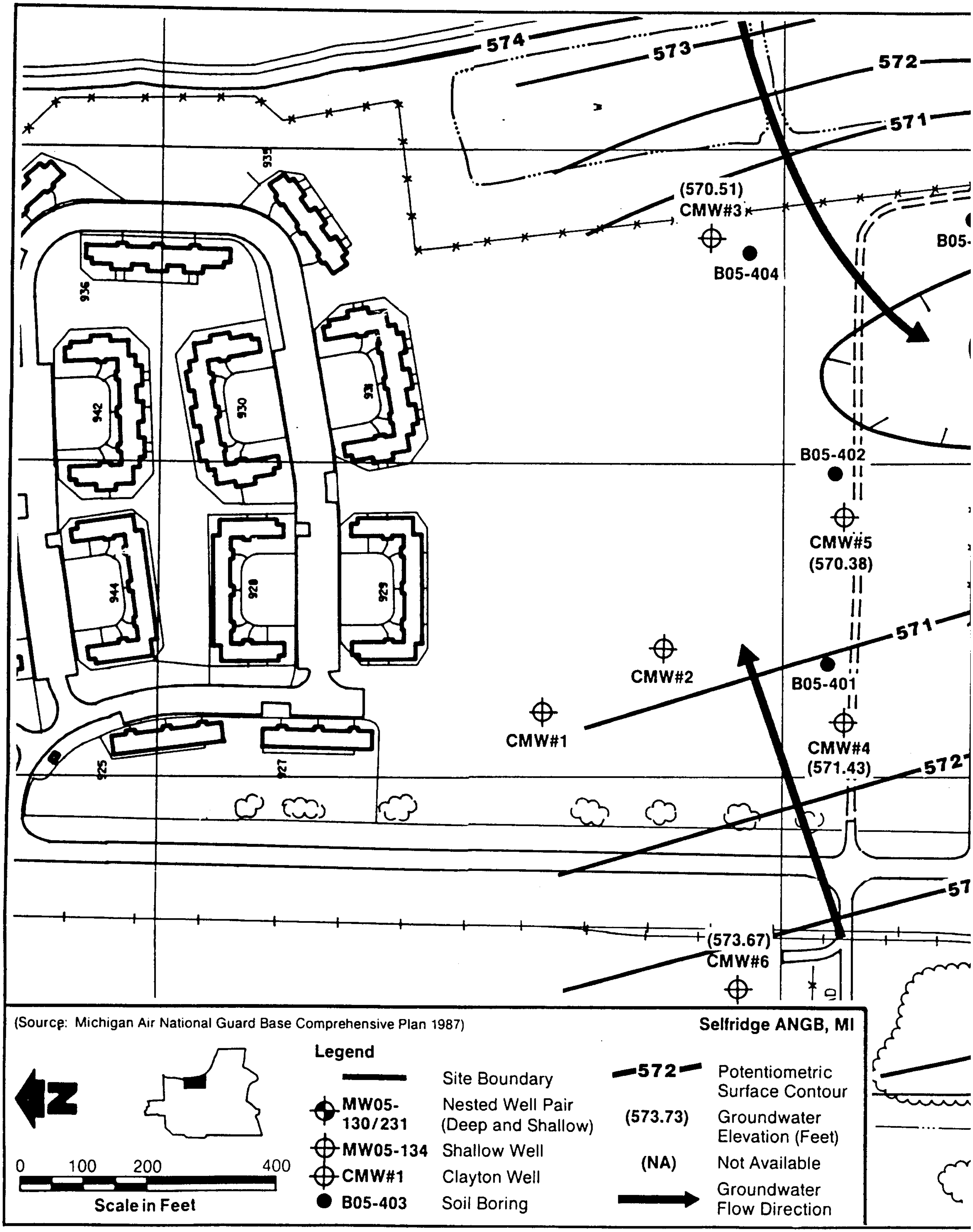
Based upon the sediments encountered during drilling at TCLF, an effective porosity value of 15 percent was used to calculate the groundwater flow velocity. The equation for calculating the flow velocity is presented in Subsection 4.4.1.3.

The groundwater flow velocity on 21 March 1988 for the shallow monitor wells was 3.61×10^{-8} ft/sec (1.14 ft/year). The flow velocity for 1 August 1988 was calculated to be 5.78×10^{-8} ft/sec (1.82 ft/year).

Based upon the data from the deep monitor wells on 21 March 1988, the calculated groundwater flow velocity was 7.02×10^{-9} ft/sec (0.22 ft/year). The flow velocity on 1 August 1988 was 9.37×10^{-9} ft/sec (0.29 ft/year).

The convergence of groundwater flow and the existence of a groundwater sink along the eastern end of TCLF on 1 August 1988 for both the shallow and deep potentiometric surface maps suggests that interception of groundwater by the stormwater drainage network is likely occurring. Groundwater collected by the stormwater drainage system would be discharged into the boat marina adjacent to the site.

Compared to the surface elevation of Lake St. Clair, water levels in the monitor wells were generally lower during all



574
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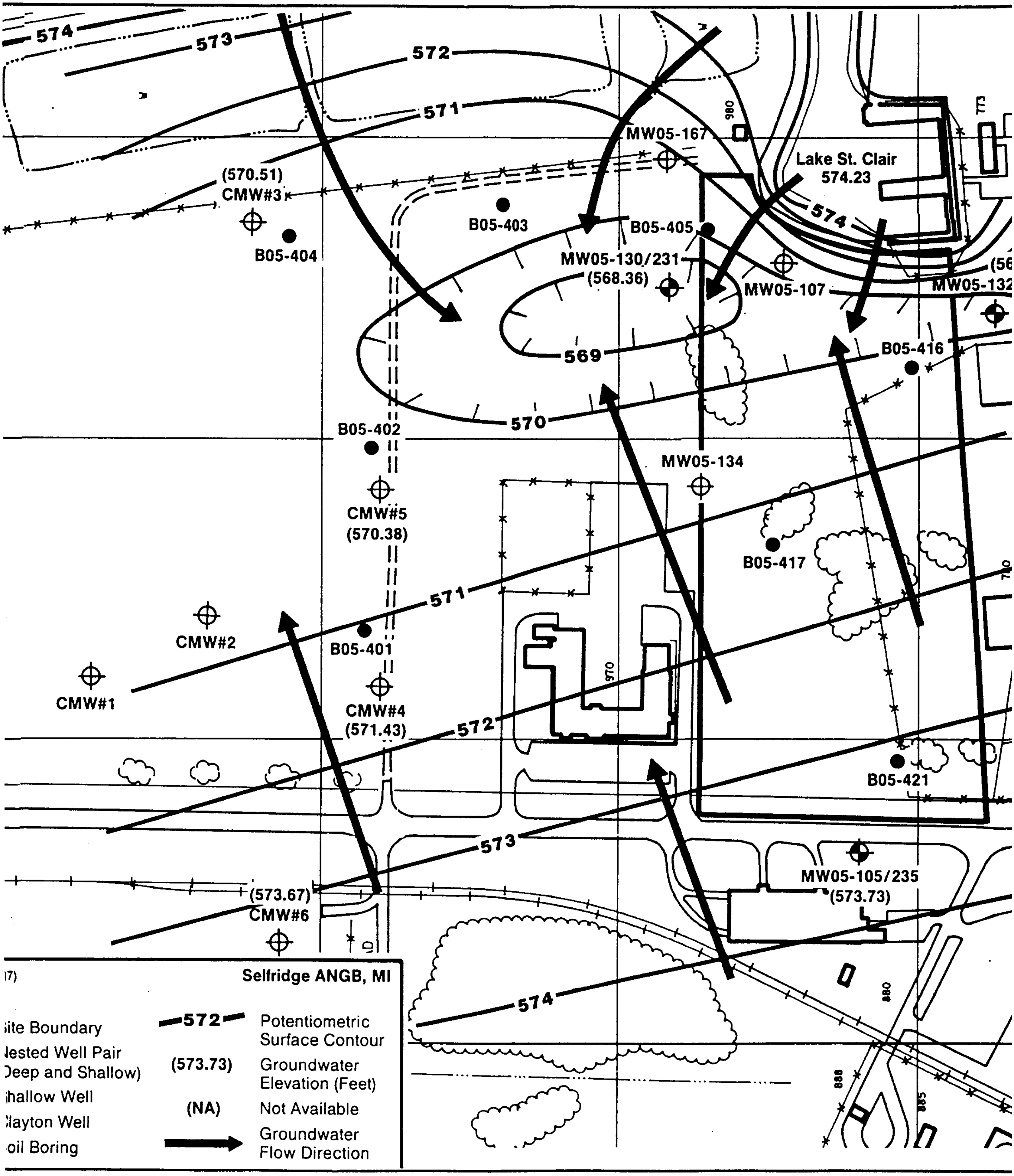
572
935
936
942
930
931
944
928
929
925
927
(570.51)
CMW#3
B05-404
B05-402
CMW#5
(570.38)
CMW#2
CMW#1
B05-401
CMW#4
(571.43)
(573.67)
CMW#6
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0 100 200 400
Scale in Feet
Legend
Site Boundary
MW05-130/231 Nested Well Pair (Deep and Shallow)
MW05-134 Shallow Well
CMW#1 Clayton Well
B05-403 Soil Boring
572 Potentiometric Surface Contour
(573.73) Groundwater Elevation (Feet)
(NA) Not Available
Groundwater Flow Direction



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571
(570.51)
CMW#3
B05-404
B05-403
MW05-167
B05-405
MW05-130/231
(568.36)
MW05-107
Lake St. Clair
574.23
574
MW05-132
B05-416
B05-402
MW05-134
CMW#5
(570.38)
B05-417
CMW#2
CMW#1
B05-401
CMW#4
(571.43)
B05-421
MW05-105/235
(573.73)
(573.67)
CMW#6
980
970
880
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Selfridge ANGB, MI
ite Boundary
Jested Well Pair
Deep and Shallow)
hallow Well
Clayton Well
oil Boring
572
Potentiometric Surface Contour
(573.73)
Groundwater Elevation (Feet)
(NA)
Not Available
Groundwater Flow Direction

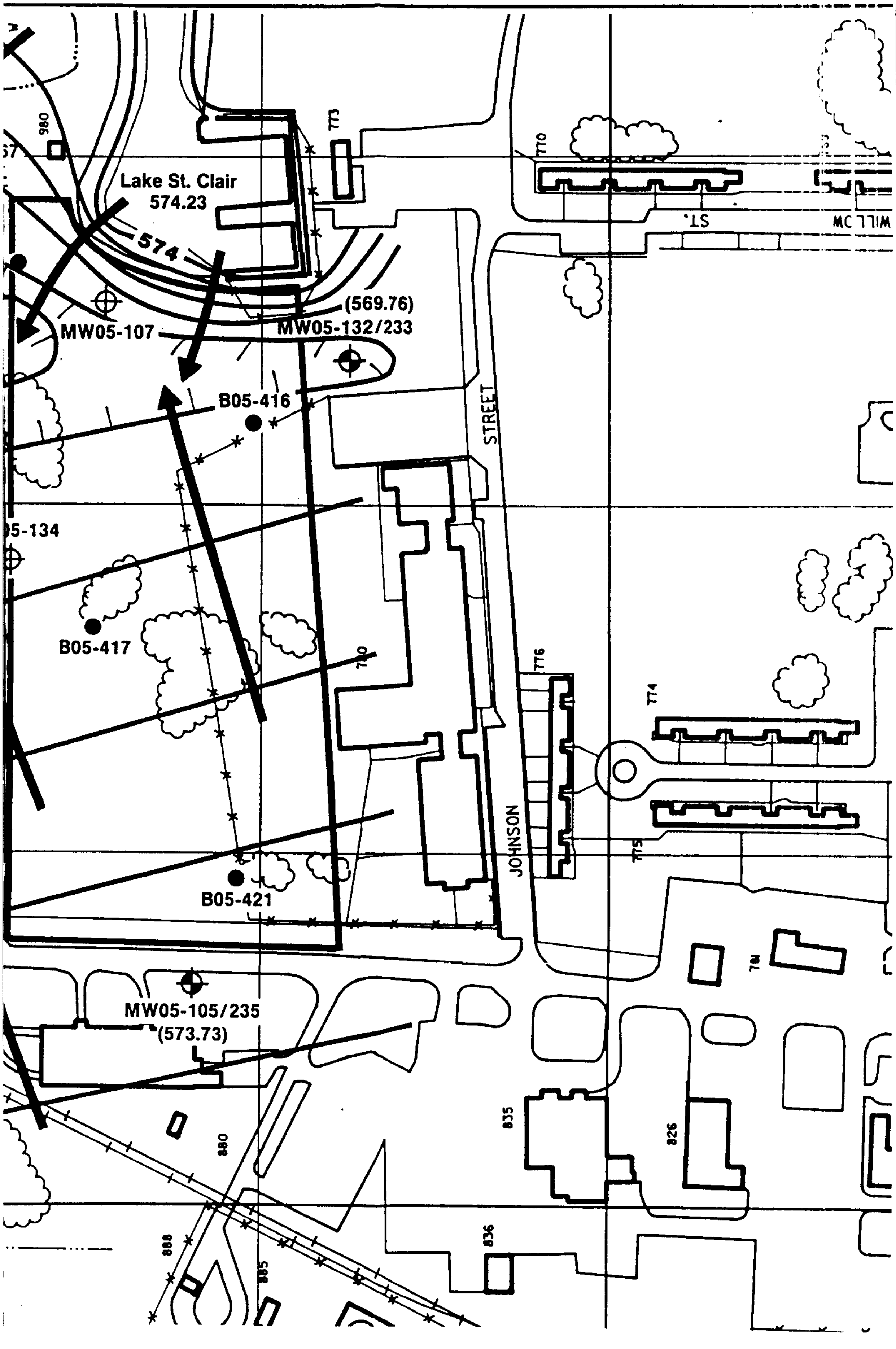


FIGURE 4-57 TCLF POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 1 AUGUST 1988

measurement periods. Monitor well 05-235 had the only water level that was above the surface elevation of Lake St. Clair. The water level in this monitor well remained above the lake level during each of the seven measurement periods.

Vertical gradients for the three monitor well nests (05-130/231, 05-132/233, and 05-105/235) were calculated based upon water level measurements on 1 August 1988, which are representative for the other measurements periods. Gradients at monitor well nests 05-130/231 (0.7 ft/ft) and 05-105/235 (0.19 ft/ft) were downward. The gradient at monitor well nest 05-132/233 (0.10 ft/ft) was upward. Basewide vertical gradients are generally upward. Interception of groundwater by the stormwater drainage system may in part cause the locally downward vertical gradients.

4.8.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- TCLF

Precipitation runoff from TCLF is collected at stormwater catch basins located throughout the site and the surrounding area. Figure 3-16 shows the locations of these catch basins. The stormwater collected is then routed through the stormwater drainage network to the pump lift station at Building 980. The water is then discharged into the boat marina next to TCLF. All surface water collected at TCLF by the stormwater drainage network would be discharged to Lake St. Clair.

Surface water may also pond in shallow depressions located across the surface of TCLF. Any contaminants on the surface of the site could be picked up by the surface water. This water may either evaporate or slowly infiltrate into the ground. This could impact the water quality of Lake St. Clair.

4.8.1.5 Direct Contact with Contaminated Media -- TCLF

Access to the TCLF site is unrestricted. Direct contact with soil, groundwater, or surface water that may be contaminated could occur due to people entering and working at the site. Base personnel that perform ground maintenance activities are the most likely to come in contact with contaminants. Workers performing excavation activities to repair or install underground utilities could also come in direct contact with any contaminants at the site. The Selfridge ANGB school is located along the southern end of the TCLF site.

4.8.1.6 Summary of Migration Pathways -- TCLF

Soils at the site are a medium that may contain and transport contaminants at TCLF. Direct contact with soil may be a pathway if excavation takes place at the site.

Groundwater flowing through TCLF is intercepted by the stormwater drainage network, based upon the site potentiometric maps, and is discharged into Lake St. Clair. Any contaminated

groundwater discharged to the lake would affect the quality of the surface water and increase the area of contamination. The chance of lake users coming in contact with TCLF contaminants would also be increased via this pathway.

4.8.2 Contamination Profile -- TCLF

4.8.2.1 Chemical Results for Soil -- TCLF

Twenty-four investigative samples and three duplicate samples were collected from eight soil borings at TCLF and were analyzed for chemical contaminants during the IRP Stage 2 investigation. The soil borings were drilled near stormwater catch basins around and within TCLF area to check for contaminant migration from the landfill area to these central drainage areas.

The soil borings were drilled and soils sampled between 17 December 1987 and 8 January 1988. The soil samples were sent to WESTON/Gulf Coast Laboratories and were analyzed for petroleum hydrocarbons, volatile organics, semivolatile organics, soil moisture content, and metals screen including arsenic, mercury, and selenium. No holding times were exceeded for these samples. The surrogate recoveries ranged from 82 to 118 percent, and the matrix spike recoveries ranged from 62 to 125 percent for the volatile organic analyses. All quantification limits were within acceptable limits. The surrogate recoveries ranged from 9 to 104 percent, and the matrix spike recoveries ranged from 48 to 107 percent for the semivolatile organic analyses. All quantification limits for semivolatile analyses were within acceptable limits, except for sample 05-401-B001. Surrogate recoveries for the matrix spike of this sample were within acceptable limits. Matrix spike recoveries for the metals screen were within 70 to 110 percent. Disparate results for silicon (1.6 percent) in spiked sample 05-416-B001 and aluminum (2,710 percent) in spiked sample 05-401-B001 occurred. Quantification limits were within acceptable limits for the metals screen.

Table 4-51 lists valid analytes and concentrations detected in soil samples collected at TCLF. Valid concentrations of acetone were detected in 05-405-B001 (0.18 mg/kg), 05-416-B002 (0.055 mg/kg), and 05-421-B003 (0.057 mg/kg) and 1,1,1-trichloroethane in soil samples 05-401-B001 (<0.003 mg/kg), 05-402-B001 (0.026 mg/kg), and 05-402-B002 (0.011 mg/kg). Toluene was detected in low concentrations (<0.002 to 0.02 mg/kg) in soil borings 05-401, 05-402, 05-403, 05-404, and 05-405. Carbon disulfide (<0.002 to <0.004 mg/kg) was detected in soil boring samples 05-401-B003 and 05-402-B002. Tetrachloroethene (<0.002 mg/kg) was detected in soil boring sample 05-402-B003. Trichloroethene (<0.002 mg/kg) and trichlorofluoromethane (<0.002 mg/kg) was detected in soil sample 05-405-B003. Ethylbenzene (<0.002 mg/kg) was detected in soil sample 05-403-B003, and 1,1,2,2-tetracholoethane (<004) was detected in soil sample

TABLE 4-51

VALID ANALYTES DETECTED IN SOIL AT TCLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE #	05-401-B001			05-401-B002			05-401-B003			05-402-B001			05-402-B002			05-402-B003		
	RFW #	120194			120195			120196			120197			120198			120305		
	SAMPLE DATE	17-DEC-87			17-DEC-87			17-DEC-87			17-DEC-87			17-DEC-87			18-DEC-87		
	DEPTH	0-5 FEET			5-10 FEET			25-27 FEET			0-5 FEET			10-15 FEET			20-25 FEET		
	% MOISTURE	32.8			29.6			10.9			29.0			28.5			9.7		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ACETONE	SW5030/SW8240	0.015		NV	0.014		NV	0.011		NV	0.014		NV	0.014		NV	0.011		NV
TOLUENE	SW5030/SW8240	0.007		ND	0.007	0.02	=	0.006	0.01	=	0.007	0.011	=	0.007		ND	0.006	0.005	<
CARBON DISULFIDE	SW5030/SW8240	0.007		ND	0.007		ND	0.006	0.002	<	0.007		ND	0.007	0.004	<	0.006		ND
ETHYLBENZENE	SW5030/SW8240	0.007		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND	0.006		ND
TRICHLOROFLUOROMETHANE	SW5030/SW8240	0.007		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND	0.006		ND
1,1,2,2-TETRACHLOROETHANE	SW5030/SW8240	0.007		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND	0.006		ND
TETRACHLOROETHENE	SW5030/SW8240	0.007		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND	0.006	0.002	<
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.007	0.003	<	0.007		ND	0.006		ND	0.007	0.026	=	0.007	0.011	=	0.006		ND
TRICHLOROETHENE	SW5030/SW8240	0.007		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND	0.006		ND
ANTHRACENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
BENZO(A)ANTHRACENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
BENZO(A)PYRENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
BENZO(B)FLUORANTHENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
BIS(2-ETHYLHEXYL) PHTHALATE	SW3550/SW2870	0.5		NV	0.47		NV	0.37		NV	0.47		NV	0.46		NV	0.37		NV
BENZO(G,H,I)PERYLENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
BENZO(K)FLUORANTHENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
CHRYSENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
DIBENZO(A,H)ANTHRACENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
FLUORANTHENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
INDENO(1,2,3-C,D)PYRENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
PHENANTHRENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
PYRENE	SW3550/SW2870	0.5		ND	0.47		ND	0.37		ND	0.47		ND	0.46		ND	0.37		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	74.4		ND	71	95	=	55.5	99	=	70.4		ND	69.9	100	=	55.4		ND
ALUMINUM, TOTAL	SW3050/SW6010	19.8	11800	=	19.6	16100	=	19.2	3670	=	19.2	15800	=	19.2	14500	=	17.2	3530	=
ARSENIC, TOTAL	SW3050/SW7060	9.3	17	=	19.5		ND	9.6	17.9	=	9.7	18.9	=	9.4	10.3	=	9.1	10.7	=
BORON, TOTAL	SW3050/SW6010	19.8		ND	19.6	28.7	=	19.2		ND	19.2		ND	19.2	26.7	=	17.2		ND
BARIUM, TOTAL	SW3050/SW6010	2.5	140	=	2.4	137	=	2.4	22.6	=	2.4	159	=	2.4	96.3	=	2.1	22.6	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.20	1.2	=	0.2	0.98	=	0.19		ND	0.19	1.2	=	0.19	0.92	=	0.17		ND
CALCIUM, TOTAL	SW3050/SW6010	9.9	9000	=	9.8	61000	=	9.6	61500	=	9.6	10800	=	9.6	37400	=	8.6	64100	=
CADMIUM, TOTAL	SW3050/SW6010	0.99		ND	0.98	1.1	=	0.96		ND	0.96	1.1	=	0.96		ND	0.86		ND
COBALT, TOTAL	SW3050/SW6010	4.0	8.3	=	3.9	13.5	=	3.8		ND	3.8	8.5	=	3.8	12.7	=	3.4		ND
CHROMIUM, TOTAL	SW3050/SW6010	2.0	20.9	=	2	25.5	=	1.9	8.2	=	1.9	24.8	=	1.9	22.1	=	1.7	5.47	=
COPPER, TOTAL	SW3050/SW6010	3.0	44.1	=	2.9	21.6	=	2.9	8.8	=	2.9	34.2	=	2.9	21.4	=	2.6	7.1	=
IRON, TOTAL	SW3050/SW6010	4.0	12600	=	3.9	26600	=	3.8	9050	=	3.8	15700	=	3.8	23900	=	3.4	8880	=
POTASSIUM, TOTAL	SW3050/SW6010	989.0		ND	978	3430	=	960		ND	961	1310	=	959	3270	=	858		ND
MAGNESIUM, TOTAL	SW3050/SW6010	19.8	3720	=	19.6	13500	=	19.2	19200	=	19.2	4710	=	19.2	12800	=	17.2	19000	=
MANGANESE, TOTAL	SW3050/SW6010	0.99	142	=	0.98	484	=	0.96	223	=	0.96	174	=	0.96	352	=	0.86	216	=
SODIUM, TOTAL	SW3050/SW6010	89.0		ND	88.1	319	=	86.4	183	=	86.4	145	=	86.3	276	=	77.2	148	=
NICKEL, TOTAL	SW3050/SW6010	4.9	38.1	=	4.9	36.2	=	4.8	9	=	4.8	40.3	=	4.8	37.9	=	4.3	8.8	=
LEAD, TOTAL	SW3050/SW6010	19.8		ND	19.6		ND	19.2		ND	19.2		ND	19.2		ND	17.2		ND
SILICON, TOTAL	SW3050/SW6010	19.8	625	=	19.6	127	=	19.2	194	=	19.2	127	=	19.2	131	=	17.2	223	=
VANADIUM, TOTAL	SW3050/SW6010	4.0	42.1	=	3.9	28.3	=	3.8	8.6	=	3.8	40.5	=	3.8	29.2	=	3.4	8.68	=
ZINC, TOTAL	SW3050/SW6010	0.99	46.1	=	0.98	65.6	=	0.96	33.8	=	0.96	53.1	=	0.96	63.7	=	0.86	25.8	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-51

(CONTINUED)

	SAMPLE #	05-403-B001			05-403-B101			05-403-B002			05-403-B003			05-404-B001			05-404-B002		
	RFW #	120306			120317			120307			120308			120309			120310		
	SAMPLE DATE	18-DEC-87			18-DEC-87			18-DEC-87			18-DEC-87			19-DEC-87			19-DEC-87		
	DEPTH	0-5 FEET			0-5 FEET			10-15 FEET			20-25 FEET			5-10 FEET			10-15 FEET		
	% MOISTURE	22.4			19.5			24.6			12.8			25.3			28.0		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ACETONE	SW5030/SW8240	0.013		NV	0.012		NV	0.013		NV	0.012		NV	0.013		NV	0.014		NV
TOLUENE	SW5030/SW8240	0.006	0.003	<	0.006		ND	0.007	0.003	<	0.006		ND	0.007		ND	0.007	0.006	<
CARBON DISULFIDE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007	0.002	<	0.006		ND	0.007		ND	0.007		ND
TRICHLOROFLUOROMETHANE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND
1,1,2,2-TETRACHLOROETHANE	SW5030/SW8240	0.006		ND	0.006	0.004	<	0.007		ND	0.006		ND	0.007		ND	0.007		ND
TETRACHLOROETHENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		ND	0.006		NV	0.007		ND	0.006		NV	0.007		ND	0.007		ND
TRICHLOROETHENE	SW5030/SW8240	0.006		ND	0.006		ND	0.007		ND	0.006		ND	0.007		ND	0.007		ND
ANTHRACENE	SW3550/SW2870	0.43	0.02	<	0.41		ND	0.44		ND	0.38		ND	0.44		ND	0.46		ND
BENZO(A)ANTHRACENE	SW3550/SW2870	0.43	0.13	<	0.41	0.1	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
BENZO(A)PYRENE	SW3550/SW2870	0.43	0.12	<	0.41	0.1	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
BENZO(B)FLUORANTHENE	SW3550/SW2870	0.43	0.12	<	0.41	0.1	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
BIS(2-ETHYLHEXYL) PHTHALATE	SW3550/SW2870	0.43		NV	0.41		NV	0.44		NV	0.38		NV	0.44		NV	0.46		NV
BENZO(G,H,I)PERYLENE	SW3550/SW2870	0.43	0.1	<	0.41	0.09	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
BENZO(K)FLUORANTHENE	SW3550/SW2870	0.43	0.11	<	0.41	0.07	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
CHRYSENE	SW3550/SW2870	0.43	0.15	<	0.41	0.11	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
DIBENZO(A,H)ANTHRACENE	SW3550/SW2870	0.43	0.11	<	0.41		ND	0.44		ND	0.38		ND	0.44		ND	0.46		ND
FLUORANTHENE	SW3550/SW2870	0.43	0.32	<	0.41	0.2	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
INDENO(1,2,3-C,D)PYRENE	SW3550/SW2870	0.43		ND	0.41	0.09	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
PHENANTHRENE	SW3550/SW2870	0.43	0.15	<	0.41	0.06	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
PYRENE	SW3550/SW2870	0.43	0.29	<	0.41	0.19	<	0.44		ND	0.38		ND	0.44		ND	0.46		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	65.1	96	=	61.8	98	=	65.3	93	=	57.1	83	=	66.9		ND	69.1	110	=
ALUMINUM, TOTAL	SW3050/SW6010	19.6	8380	=	18.1	8630	=	19.7	10600	=	16.4	6830	=	18.6	13100	=	19.8	12400	=
ARSENIC, TOTAL	SW3050/SW7060	4.7	14.1	=	9.2	43.2	=	9.1		ND	9.6		ND	9.7	12.9	=	7.7	13	=
BORON, TOTAL	SW3050/SW6010	19.6		ND	18.1		ND	19.7	26.6	=	16.4		ND	18.6	20.3	=	19.8	23	=
BARIUM, TOTAL	SW3050/SW6010	2.4	88.8	=	2.3	71	=	2.5	63	=	2.0	48.2	=	2.3	114	=	2.5	84.1	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.2	0.35	=	0.18	0.57	=	0.2	0.75	=	.16	0.42	=	0.19	0.98	=	0.2	0.75	=
CALCIUM, TOTAL	SW3050/SW6010	9.8	19200	=	9	35500	=	9.9	42400	=	8.2	62200	=	9.3	49100	=	9.9	57700	=
CADMIUM, TOTAL	SW3050/SW6010	0.98		ND	0.9		ND	0.99	1.3	=	.82	1.0	=	0.93	1.1	=	0.99		ND
COBALT, TOTAL	SW3050/SW6010	3.9	6.2	=	3.6	7.2	=	3.9	12.7	=	3.3	6.3	=	3.7	14.2	=	4	11.5	=
CHROMIUM, TOTAL	SW3050/SW6010	2	15.3	=	1.8	13.9	=	2	16.9	=	1.6	11.6	=	1.9	20.9	=	2	21.1	=
COPPER, TOTAL	SW3050/SW6010	2.9	18.6	=	2.7	17.9	=	3	24.7	=	2.4	11.2	=	2.8	19.7	=	3	17.8	=
IRON, TOTAL	SW3050/SW6010	3.9	13000	=	3.6	15300	=	3.9	23200	=	3.3	13800	=	3.7	26800	=	4	23300	=
POTASSIUM, TOTAL	SW3050/SW6010	978	1540	=	904		ND	986	2140	=	819	1370	=	930	1900	=	989	2560	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.6	6010	=	18.1	13000	=	19.7	12700	=	16.4	19600	=	18.6	9920	=	19.8	15500	=
MANGANESE, TOTAL	SW3050/SW6010	0.98	313	=	0.9	386	=	0.99	483	=	.82	284	=	0.93	605	=	0.99	493	=
SODIUM, TOTAL	SW3050/SW6010	88	93.5	=	81.4	90.8	=	88.8	293	=	73.7	247	=	83.7	150	=	89	279	=
NICKEL, TOTAL	SW3050/SW6010	4.9	17.1	=	4.5	18.8	=	4.9	39.5	=	4.1	16.0	=	4.6	35.9	=	4.9	35.5	=
LEAD, TOTAL	SW3050/SW6010	19.6	82.2	=	18.1	22.5	=	19.7		ND	16.4		ND	18.6		ND	19.8		ND
SILICON, TOTAL	SW3050/SW6010	19.6	730	=	18.1	383	=	19.7	601	=	16.4	340	=	18.6	484	=	19.8	104	=
VANADIUM, TOTAL	SW3050/SW6010	3.9	18.9	=	3.6	19.1	=	3.9	20.7	=	3.3	15.4	=	3.7	27.8	=	4	22.5	=
ZINC, TOTAL	SW3050/SW6010	0.98	95.6	=	0.9	56.6	=	0.99	66.2	=	.82	35.2	=	0.93	60.9	=	0.99	59.9	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-51

(CONTINUED)

ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
	SAMPLE #	05-404-B003			05-405-B001			05-405-B002			05-405-B003			05-405-B103			05-416-B001		
	RFW #	120311			120313			120314			120315			120316			121270		
	SAMPLE DATE	19-DEC-87			19-DEC-87			19-DEC-87			19-DEC-87			19-DEC-87			06-JAN-88		
	DEPTH	20-21.5 FEET			5-10 FEET			20-24 FEET			24-26 FEET			24-26 FEET			5-10 FEET		
	% MOISTURE	10.6			30.7			14.4			7.3			9.0			28.6		
ACETONE	SW5030/SW8240	0.011		NV	0.013	0.18	=	0.012		NV	0.011		NV	0.011		ND	0.014		ND
TOLUENE	SW5030/SW8240	0.006	0.003	<	0.007		ND	0.006	0.002	<	0.005	0.004	<	0.006	0.013	=	0.007		ND
CARBON DISULFIDE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.005		ND	0.006		ND	0.007		ND
ETHYLBENZENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.005		ND	0.006		ND	0.007		ND
TRICHLOROFLUOROMETHANE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.005	0.002	<	0.006		ND	0.007		ND
1,1,2,2-TETRACHLOROETHANE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.005		ND	0.006		ND	0.007		ND
TETRACHLOROETHENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.005		ND	0.006		ND	0.007		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006		NV	0.007		NV	0.006		NV	0.005		NV	0.006		NV	0.007		ND
TRICHLOROETHENE	SW5030/SW8240	0.006		ND	0.007		ND	0.006		ND	0.005	0.002	<	0.006		ND	0.007		ND
ANTHRACENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
BENZO(A)ANTHRACENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
BENZO(A)PYRENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
BENZO(B)FLUORANTHENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
BIS(2-ETHYLHEXYL) PHTHALATE	SW3550/SW2870	0.36		NV	0.46		NV	0.39		NV	0.35		NV	0.36		NV	0.46		ND
BENZO(G,H,I)PERYLENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
BENZO(K)FLUORANTHENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
CHRYSENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
DIBENZO(A,H)ANTHRACENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
FLUORANTHENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
INDENO(1,2,3-C,D)PYRENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
PHENANTHRENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
PYRENE	SW3550/SW2870	0.36		ND	0.46		ND	0.39		ND	0.35		ND	0.36		ND	0.46		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	55.9		ND	71.8	120	=	57.5		ND	53.7		ND	54.9		ND	69		ND
ALUMINUM, TOTAL	SW3050/SW6010	18.3	4440	=	19.9	15200	=	19.3	5950	=	19.8	5010	=	19.3	5350	=	18.6	16400	=
ARSENIC, TOTAL	SW3050/SW7060	7.3		ND	9.2	19.5	=	6.8	9	=	7.8		ND	9	9.1	=	9.5	17.2	=
BORON, TOTAL	SW3050/SW6010	18.3		ND	19.9	26.4	=	19.3		ND	19.8		ND	19.3		ND	18.6	21.8	=
BARIUM, TOTAL	SW3050/SW6010	2.3	30.8	=	2.5	83	=	2.4	36.2	=	2.5	30.9	=	2.4	33.4	=	2.3	137	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.18	0.32	=	0.2	0.97	=	0.19	0.38	=	0.2	0.33	=	0.19	0.34	=	.19	1	=
CALCIUM, TOTAL	SW3050/SW6010	9.1	61500	=	9.9	47300	=	9.6	65400	=	9.9	83200	=	9.6	72900	=	9.3	42200	=
CADMIUM, TOTAL	SW3050/SW6010	0.91	1.1	=	0.99		ND	0.96		ND	0.99	1.3	=	0.96	1.1	=	.93	1.5	=
COBALT, TOTAL	SW3050/SW6010	3.6	4.3	=	4	13.7	=	3.8	5.2	=	4	4.8	=	3.9	4.9	=	3.7	14.1	=
CHROMIUM, TOTAL	SW3050/SW6010	1.8	8.42	=	2	23.9	=	1.9	10.4	=	2	8.3	=	1.9	10.5	=	1.9	24.4	=
COPPER, TOTAL	SW3050/SW6010	2.7	6.9	=	3	19.5	=	2.9	7.5	=	3	6.2	=	2.9	6.9	=	2.8	21.2	=
IRON, TOTAL	SW3050/SW6010	3.6	9970	=	4	26000	=	3.8	12400	=	4	10400	=	3.9	10800	=	3.7	27400	=
POTASSIUM, TOTAL	SW3050/SW6010	915		ND	993	3060	=	964	1210	=	992	1050	=	965	1090	=	933	3090	=
MAGNESIUM, TOTAL	SW3050/SW6010	18.3	19200	=	19.9	11500	=	19.3	18800	=	19.8	25500	=	19.3	21400	=	18.6	16200	=
MANGANESE, TOTAL	SW3050/SW6010	0.91	244	=	0.99	444	=	0.96	274	=	0.99	247	=	0.96	261	=	.93	405	=
SODIUM, TOTAL	SW3050/SW6010	82.3	171	=	89.4	318	=	86.8	286	=	89.3	250	=	86.9	268	=	89.6	325	=
NICKEL, TOTAL	SW3050/SW6010	4.6	10.4	=	5	38.7	=	4.8	12.7	=	5	10.1	=	4.8	11.2	=	4.7	37.8	=
LEAD, TOTAL	SW3050/SW6010	18.3		ND	19.9		ND	19.3		ND	19.8		ND	19.3		ND	18.6		ND
SILICON, TOTAL	SW3050/SW6010	18.3	169	=	19.9	283	=	19.3	154	=	19.8	124	=	19.3	123	=	18.6	284	=
VANADIUM, TOTAL	SW3050/SW6010	3.6	10.9	=	4	28.9	=	3.8	14.5	=	4	11.2	=	3.9	12.2	=	3.7	31.3	=
ZINC, TOTAL	SW3050/SW6010	0.91	28.6	=	0.99	65.6	=	0.96	30.6	=	0.99	23.9	=	0.96	27.1	=	.93	74.9	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-51

(CONTINUED)

	SAMPLE #	05-416-B002			05-416-B102			05-416-B003			05-417-B001			05-417-B002			05-417-B002		
	RFW #	121271			121272			121273			121274			121275			121276		
	SAMPLE DATE	06-JAN-88			06-JAN-88			06-JAN-88			06-JAN-88			06-JAN-88			06-JAN-88		
	DEPTH	15-20 FEET			15-20 FEET			25-26 FEET			8-9 FEET			14-19 FEET			14-19 FEET		
	% MOISTURE	30.1			27.0			8.2			29.2			34.0			33.9		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ACETONE	SW5030/SW8240	0.014	0.055	=	0.014		NV	0.011		ND	0.014		NV	0.015	0.026	=	0.007		NV
TOLUENE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
CARBON DISULFIDE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
ETHYLBENZENE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
TRICHLOROFLUOROMETHANE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
1,1,2,2-TETRACHLOROETHANE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
TETRACHLOROETHENE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
TRICHLOROETHANE	SW5030/SW8240	0.007		ND	0.007		ND	0.005		ND	0.007		ND	0.008		ND	0.008		ND
ANTHRACENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
BENZO(A)ANTHRACENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
BENZO(A)PYRENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
BENZO(B)FLUORANTHENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
BIS(2-ETHYLHEXYL) PHTHALATE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
BENZO(G,H,I)PERYLENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
BENZO(K)FLUORANTHENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
CHRYSENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
DIBENZO(A,H)ANTHRACENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
FLUORANTHENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
INDENO(1,2,3-C,D)PYRENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
PHENANTHRENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
PYRENE	SW3550/SW2870	0.49		ND	0.45		ND	0.34		ND	0.46		ND	0.5		ND	0.5		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	71.5		ND	67.8		ND	53.9		ND	69.9	75	=	75.8		ND	74.5		ND
ALUMINUM, TOTAL	SW3050/SW6010	19.6	14500	=	20	12300	=	19	5450	=	19.8	16100	=	19.6	16200	=	19.4	15500	=
ARSENIC, TOTAL	SW3050/SW7060	24.7		ND	18.9	24	=	9		ND	16.8		ND	9.8		ND	9.8	14	=
BORON, TOTAL	SW3050/SW6010	19.6	22.7	=	20	25.6	=	19		ND	19.8	24.3	=	19.6	27.4	=	19.4	28.8	=
BARIUM, TOTAL	SW3050/SW6010	2.4	109	=	2.5	97.8	=	2.4	33	=	2.5	107	=	2.4	124	=	2.4	118	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.2	0.77	=	0.2	0.72	=	0.19	0.28	=	0.2	0.92	=	0.2	0.9	=	0.19	0.88	=
CALCIUM, TOTAL	SW3050/SW6010	9.8	72100	=	10	44900	=	9.5	68400	=	9.9	40700	=	9.8	71500	=	9.7	74700	=
CADMIUM, TOTAL	SW3050/SW6010	0.98		ND	1	1.1	=	0.95		ND	0.99		ND	0.98		ND	0.97		ND
COBALT, TOTAL	SW3050/SW6010	3.9	11.8	=	4	11.5	=	3.8	5.1	=	4	14	=	3.9	12.6	=	3.9	12.5	=
CHROMIUM, TOTAL	SW3050/SW6010	2	23.2	=	2	20	=	1.9	9.5	=	2	24.7	=	2	25.3	=	1.9	24.1	=
COPPER, TOTAL	SW3050/SW6010	2.9	17.8	=	3	21.7	=	2.8	7.7	=	3	20.7	=	2.9	18.1	=	2.9	18.7	=
IRON, TOTAL	SW3050/SW6010	3.9	23100	=	4	22800	=	3.8	11700	=	4	26400	=	3.9	25600	=	3.9	24600	=
POTASSIUM, TOTAL	SW3050/SW6010	978	3100	=	999	2470	=	948	1110	=	988	3290	=	978	3410	=	968	3180	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.6	15000	=	20	18200	=	19	20900	=	19.8	12600	=	19.6	14800	=	19.4	14400	=
MANGANESE, TOTAL	SW3050/SW6010	0.98	430	=	1	367	=	0.95	253	=	0.99	456	=	0.98	447	=	0.97	466	=
SODIUM, TOTAL	SW3050/SW6010	86.4	764	=	86.4	734	=	88.6	337	=	8.9	259	=	87	423	=	89.3	459	=
NICKEL, TOTAL	SW3050/SW6010	4.9	31.2	=	5	31.5	=	4.7	12.7	=	4.9	40.5	=	4.9	35.1	=	4.8	35.8	=
LEAD, TOTAL	SW3050/SW6010	19.6		ND	20		ND	19		ND	19.8		ND	19.6		ND	19.4		ND
SILICON, TOTAL	SW3050/SW6010	19.6	70.4	=	20	183	=	19	44.9	=	19.8	34.5	=	19.6	41.2	=	19.4	84.6	=
VANADIUM, TOTAL	SW3050/SW6010	3.9	24.5	=	4	25.8	=	3.8	13.3	=	4	32.6	=	3.9	26.9	=	3.9	27.9	=
ZINC, TOTAL	SW3050/SW6010	0.98	59.9	=	1	56.8	=	0.95	29.6	=	0.99	65.3	=	0.98	64	=	0.97	76.3	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-51

(CONTINUED)

	SAMPLE #	05-417-B003			05-421-B001			05-421-B002			05-421-B003		
	RFW #	121277			121378			121379			121380		
	SAMPLE DATE	06-JAN-88			08-JAN-88			08-JAN-88			08-JAN-88		
	DEPTH	24-25 FEET			0-4.1 FEET			10-15 FEET			25-29.6 FEET		
	% MOISTURE	8.1			26.3			34.5			26.0		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ACETONE	SW5030/SW8240	0.011		ND	0.014		ND	0.016		ND	0.014	0.057	=
TOLUENE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
CARBON DISULFIDE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
ETHYL BENZENE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
TRICHLOROFLUOROMETHANE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
1,1,2,2-TETRACHLOROETHANE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
TETRACHLOROETHENE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
TRICHLOROETHANE	SW5030/SW8240	0.005		ND	0.007		ND	0.008		ND	0.007		ND
ANTHRACENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
BENZO(A)ANTHRACENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
BENZO(A)PYRENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
BENZO(B)FLUORANTHENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
BIS(2-ETHYLHEXYL)PHTHALATE	SW3550/SW2870	0.35		ND	0.45	0.4	<	0.48		ND	0.43		ND
BENZO(G,H,I)PERYLENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
BENZO(K)FLUORANTHENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
CHRYSENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
DIBENZO(A,H)ANTHRACENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
FLUORANTHENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
INDENO(1,2,3-CD)PYRENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
PHENANTHRENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
PYRENE	SW3550/SW2870	0.35		ND	0.45		ND	0.48		ND	0.43		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	53.6		ND	67.5		ND	75.6		ND	66.9		ND
ALUMINUM, TOTAL	SW3050/SW6010	19.4	4080	=	19.9	13300	=	19.9	15200	=	19.8	5540	=
ARSENIC, TOTAL	SW3050/SW7060	9.8		ND	9.8		ND	4.7	12.2	=	4.3	9.5	=
BORON, TOTAL	SW3050/SW6010	19.4		ND	19.9		ND	19.9	27.7	=	19.8		ND
BARIUM, TOTAL	SW3050/SW6010	2.4	24	=	2.5	110	=	2.5	129	=	2.5	31.4	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.19	0.21	=	.20	0.76	=	0.2	0.85	=	0.2	0.33	=
CALCIUM, TOTAL	SW3050/SW6010	9.7	67700	=	9.9	5240	=	10	43700	=	9.9	78200	=
CADMIUM, TOTAL	SW3050/SW6010	0.97	1.4	=	.99		ND	1		ND	0.99	1.7	=
COBALT, TOTAL	SW3050/SW6010	3.9	4.1	=	4.0	11.3	=	4	12.9	=	4	5.2	=
CHROMIUM, TOTAL	SW3050/SW6010	1.9	7.9	=	2.0	22	=	2	23.9	=	2	8.6	=
COPPER, TOTAL	SW3050/SW6010	2.9	7.7	=	3.0	24.3	=	3	23	=	3		NV
IRON, TOTAL	SW3050/SW6010	3.9	10700	=	4.0	20400	=	4	24400	=	4	11600	=
POTASSIUM, TOTAL	SW3050/SW6010	970		ND	993	1530	=	997	3220	=	992	1170	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.4	23400	=	19.9	5470	=	19.9	15900	=	19.8	24300	=
MANGANESE, TOTAL	SW3050/SW6010	0.97	238	=	.99	241	=	1	372	=	0.99	261	=
SODIUM, TOTAL	SW3050/SW6010	85.1	195	=	89.4	1260	=	89.7	1330	=	89.3	1240	=
NICKEL, TOTAL	SW3050/SW6010	4.8	10.6	=	5.0	31.5	=	5	34	=	5	12.3	=
LEAD, TOTAL	SW3050/SW6010	19.4		ND	19.9		ND	19.9		ND	19.8		ND
SILICON, TOTAL	SW3050/SW6010	19.4	84.3	=	19.9	102	=	19.9	228	=	19.8	225	=
VANADIUM, TOTAL	SW3050/SW6010	3.9	10.9	=	4.0	29.6	=	4	28.6	=	4	14.2	=
ZINC, TOTAL	SW3050/SW6010	0.97	28	=	.99	58.1	=	1	63.6	=	0.99	36.5	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

05-403-B101. Twelve semivolatile organics were detected in soil samples 05-403-B001 and 05-403-B101. The concentrations ranged from <0.02 to <0.32 mg/kg. The constituents detected included pyrene, anthracene, benzo(a)pyrene, and chrysene which are typical of coal tar or wood preservatives used for treating railroad ties. Bis(2-ethylhexyl) phthalate (<0.4 mg/kg) was detected in sample 05-421-B001. Petroleum hydrocarbons were detected in soil boring 05-401 (95 to 99 mg/kg), soil boring 05-402 (100 mg/kg), soil boring 05-403 (83 to 98 mg/kg), soil boring 05-404 (82 to 110 mg/kg), soil boring 05-405 (120 mg/kg), and soil boring 05-417 (75 mg/kg). The concentrations occurred at all depths of the soil borings.

All concentrations of metals were within the naturally occurring observed range of these elements for the eastern conterminous United States (USGS Professional Paper 1270). A few metals were detected above background ranges determined in the statistical study listed in Table 4-20. Metals above background were arsenic detected at 43.2 mg/kg in soil sample 05-403-B101 and lead detected at 22.5 and 82.2 mg/kg in soil samples 05-403-B001 and 05-403-B101. Barium was detected at concentrations of 140 and 159 mg/kg and copper was detected in concentrations of 44.1 and 34.2 mg/kg in soil samples 05-401-B001 and 05-402-B001, respectively. Zinc was detected at concentrations of 95.6, 74.9, and 76.3 mg/kg in soils samples 05-403-B001, 05-416-B001, and 05-417-B002, respectively. The concentrations for arsenic, barium, copper, lead, and zinc were the highest detected in soil samples analyzed during the IRP Stage 2 IRP investigation.

4.8.2.2 Chemical Results for Groundwater -- TCLF

One duplicate and nine investigative groundwater samples were retained for analyses of chemical contaminants during the IRP Stage 2 investigation at TCLF. They were collected from monitor wells placed around and within the perimeter of TCLF to detect groundwater contamination. The groundwater samples were collected between 12 April and 23 April 1988.

The groundwater samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, COD, TOC, alkalinity, and TDS. Holding times were exceeded for common anions for samples 05-107-M001, 05-167-M001, 05-132-M001, 05-233-M001, and 05-231-M001. The monitor wells were resampled on 20 and 21 June 1988 for these parameters. Holding times were exceeded for ammonia for samples 05-105-M001 and 05-235-M001 and for TDS for samples 05-107-M001, 05-167-M001, 05-130-M001, 05-130-M101, 05-132-M001, 05-233-M001, and 05-231-M001. These wells were resampled for these parameters from 3 August to 5 August 1988. No holding times were exceeded for the resampled groundwater.

Surrogate recoveries for purgeable halocarbons analyses ranged from 51 to 98 percent, and matrix spike recoveries ranged from 51 to 80 percent. Surrogate recoveries for purgeable aromatics analyses ranged from 42 to 97 percent. Semivolatile surrogate recoveries ranged from 1 to 195 percent. All samples were within quality control limits except 05-134-M001 and 05-132-M001. Sample 05-134-M001, with an initial 1 percent surrogate recovery, was re-extracted, with similar surrogate recovery results indicating matrix interference. Sample 05-132-M001 was not re-extracted because the bulk of the sample was used for matrix spike and matrix spike duplicate analyses. Matrix spike recoveries for semivolatile organics ranged from 45 to 172 percent. Matrix spikes on metals samples ranged from 0 to 107 percent on sample 05-132-M001. Interference matrix spike recoveries occurred for beryllium, lead, and selenium. Because of insufficient sample the analyses were not repeated. All other surrogate recoveries, matrix spike recoveries, and detection limits were within quality control limits.

Table 4-52 lists valid analytes and concentrations detected in groundwater samples collected at TCLF. Purgeable halocarbons and aromatics analyses detected (confirmed by second column analyses) trace quantities of benzene (2 ug/L) and trichloroethene (4.1 ug/L) in groundwater sample 05-107-M001. Groundwater sample 05-167-M001 contained trace quantities of 1,4-dichlorobenzene (<2 ug/L). Methylene chloride was detected in groundwater sample 05-105-M001, and petroleum hydrocarbons were detected in groundwater samples 05-105-M001 (1 mg/L), 05-107-M001 (1.4 mg/L), 05-132-M001 (4.1 mg/L), 05-233-M001 (1.4 mg/L), and 05-231-M001 (1.2 mg/L). Semivolatile analyses detected trace concentrations (<1 to <4 ug/L) of common plasticizers bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, and di-n-butyl phthalate in all the groundwater samples collected at TCLF, except 05-107-M001 and 05-130-M001. Such trace concentrations can be indicative of laboratory or shipping contamination.

Barium (0.127 to 0.929 mg/L) was detected in each groundwater sample from TCLF. High concentrations were detected in groundwater samples 05-233-M001 (0.929 mg/L), 05-105-M001 (0.629 mg/L), 05-231-M001 (0.528 mg/L), and 05-167-M001 (0.421 mg/L). Cadmium (0.006 to 0.008 mg/L) was detected in low concentrations in groundwater samples 05-107-M001, 05-167-M001, 05-130-M101, and 05-233-M001. Copper was detected (0.026 to 0.03 mg/L) in groundwater samples 05-167-M001 and 05-233-M001. Nickel was detected in low concentrations (0.019 to 0.055 mg/L) in samples from monitor wells 05-107, 05-130, 05-132, and 05-233. Lead (0.005 mg/L) was detected in sample 05-231-M001. Zinc (0.11 to 0.32 mg/L) was detected in monitor wells 05-107, 05-130, 05-132, 05-134, and 05-231 at background concentrations. None of these metals detections exceed drinking water standards.

TABLE 4-52

VALID ANALYTES DETECTED IN GROUNDWATER AT TCLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE		05-105-M001 128054 12-APR-88			05-107-M001 129059 23-APR-88			05-130-M001 128933 21-APR-88			05-130-M101 128934 21-APR-88			05-132-M001 129017 22-APR-88			05-134-M001 128175 13-APR-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
METHYLENE CHLORIDE	E601	ug/L	2	2 (ND)	=	2		ND	2		ND	2		ND	2		ND	2		ND
TRICHLOROETHENE	E601	ug/L	0.6		ND	0.6	4.1(2.2)	=	0.6		ND	0.6		ND	0.6		ND	0.6		ND
BENZENE	SW5030/SW8020	ug/L	2		ND	2	2 (2)	=	2		ND	2		ND	2		ND	2		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10	1	<	10		ND	10		ND	10		ND	10		ND	9		ND
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10	4	<	10	1	<	10		ND	10		NV	10	4	<	9	2	<
DI-N-BUTYL PHTHALATE	E625	ug/L	10		ND	10	2	<	10		ND	10	1	<	10		ND	9		ND
1,4-DICHLOROBENZENE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND	9		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.05	1	=	1.18	1.4	=	1.18		NV	1.19		NV	1.27	4.1	=	1.14		ND
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND
BORON, TOTAL	E200.7	mg/L	.100	0.288	=	.100	0.374	=	.100	0.31	=	.100	0.296	=	.100	0.146	=	.100	0.104	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.629	=	.0500	0.134	=	.0500	0.127	=	.0500	0.129	=	.0500	0.196	=	.0500	0.29	=
BERYLLIUM, TOTAL	E200.7	mg/L	.0020		ND	.0020		ND	.0020		ND	.0020		ND	.0020		ND	.0020		ND
CALCIUM, TOTAL	E200.7	mg/L	.200	133	=	.200	167	=	.200	300	=	.200	301	=	.200	217	=	.200	225	=
CADMIUM, TOTAL	E200.7	mg/L	.0050		ND	.0050	0.006	=	.0050		ND	.0050	0.006	=	.0050		ND	.0050		ND
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND	.0250		ND	.0250		ND	.0250		ND	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400		ND	.0400		ND	.0400		ND	.0400	0.053	=	.0400		ND	.0400	0.053	=
POTASSIUM, TOTAL	E200.7	mg/L	5.00	10.9	=	5.00		ND	5.00	6.76	=	5.00	6.71	=	5.00		ND	5.00		ND
MAGNESIUM, TOTAL	E200.7	mg/L	.200	19.2	=	.200	87.8	=	.200	74.5	=	.200	75	=	.200	77.2	=	.200	71.2	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.2	=	.0100	0.735	=	.0100	1.01	=	.0100	1.03	=	.0100	1.24	=	.0100	1.79	=
SODIUM, TOTAL	E200.7	mg/L	.900	790	=	.900	288	=	.900	42.6	=	.900	45.2	=	.900	135	=	.900	55.1	=
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150	0.025	=	.0150	0.019	=	.0150	0.021	=	.0150	0.055	=	.0150	0.045	=
LEAD, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050		ND
SILICON, TOTAL	E200.7	mg/L	.300	7.2	=	.300	5.62	=	.300	5.22	=	.300	5.39	=	.300	4.86	=	.300	8.54	=
ZINC, TOTAL	E200.7	mg/L	.0100		ND	.0100	0.025	=	.0100	0.015	=	.0100	0.015	=	.0100	0.023	=	.0100	0.011	=
ALKALINITY	A403	mg/L	10	180	=	10	480	=	10	610	=	10	570	=	10	470	=	10	790	=
COD	A508A	mg/L	5	45	=	5	57	=	5	76	=	5	69	=	5	52	=	5	45	=
FLUORIDE	E340.2	mg/L	0.1		NV	0.1	0.6	=	0.1		NV	0.1		NV	0.1	0.2	=	0.1		NV
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1	0.1	=	0.1		ND	0.1		ND	0.1		ND	0.1		ND
AMMONIA	E350.3	mg/L	0.1		HT	0.1	1.6	=	0.1	0.8	=	0.1	0.7	=	0.1	0.5	=	0.1	0.7	=
TOC	E415.1	mg/L	0.1	9.3	=	0.1	7	=	0.1	13	=	0.1	13	=	0.1	7.2	=	0.1	8.8	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	2500	=	10		HT	10		HT	10		HT	10		HT	10	1100	=
	SAMPLE # / RFW # / SAMPLE DATE		05-105-M001 8804-092-007 12-APR-88			05-107-M021 8806-760-002 20-JUN-88			05-130-M001 8804-183-027 21-APR-88			05-130-M101 128934 21-APR-88			05-132-M021 8806-760-005 21-JUN-88			05-134-M001 8804-113-002 13-APR-88		
CHLORIDE	A429	mg/L	125	1080	=	125	870	=	2.5	22.9	=	2.5	22.1	=	125	450	=	25	96.4	=
SULFATE	A429	mg/L	2.5	13.5	=	125	165	=	25	149	=	25	161	=	125	260	=	25	205	=
	SAMPLE # / RFW # / SAMPLE DATE		05-105-M021 137013 05-AUG-88			05-107-M021 136801 03-AUG-88			05-130-M021 137009 04-AUG-88			05-107-M121 136802 03-AUG-88			05-132-M021 137010 04-AUG-88					
AMMONIA	E350.3	mg/L	0.1	1.3	=										0.1	0.5	=			
TOTAL DISSOLVED SOLIDS	E160.1	mg/L				10	1800	=	10	1700	=	10	1900	=	10	2000	=			

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-52

(CONTINUED)

ANALYTE	METHOD	UNIT	05-167-M001 DL	R	QL	05-231-M001 DL	R	QL	05-233-M001 DL	R	QL	05-235-M001 DL	R	QL
	SAMPLE # / RFW # / SAMPLE DATE		05-167-M001 129060 23-APR-88			05-231-M001 129061 23-APR-88			05-233-M001 129019 22-APR-88			05-235-M001 128055 23-APR-88		
METHYLENE CHLORIDE	E601	ug/L	2		ND	2		ND	2		ND	2		ND
TRICHLOROETHENE	E601	ug/L	0.6		ND	0.6		ND	0.6		ND	0.6		ND
BENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	17		ND	10		ND	10	1	<
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10	2	<	17	4	<	10	2	<	10	1	<
DI-N-BUTYL PHTHALATE	E625	ug/L	10	1	<	17		ND	10	2	<	10		NV
1,4-DICHLOROBENZENE	E625	ug/L	10	2	<	17		ND	10		ND	10		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.16		ND	1.14	1.2	=	1.04	1.4	=	1.27	4.1	=
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050	0.007	=
BORON, TOTAL	E200.7	mg/L	.100	0.313	=	.100	0.292	=	.100	0.507	=	.100		ND
BARIUM, TOTAL	E200.7	mg/L	.0500	0.421	=	.0500	0.528	=	.0500	0.929	=	.0500	0.296	=
BERYLLIUM, TOTAL	E200.7	mg/L	.0020		ND	.0020		ND	.0020		ND	.0020	0.412	=
CALCIUM, TOTAL	E200.7	mg/L	.200	180	=	.200	197	=	.200	178	=	.200	72	=
CADMIUM, TOTAL	E200.7	mg/L	.0050	0.008	=	.0050		ND	.0050	0.008	=	.0050		ND
COPPER, TOTAL	E200.7	mg/L	.0250	0.026	=	.0250		ND	.0250	0.03	=	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400		ND	.0400		ND	.0400	0.068	=	.0400		ND
POTASSIUM, TOTAL	E200.7	mg/L	5.00		ND	5.00	12.7	=	5.00	55	=	5.00	13.5	=
MAGNESIUM, TOTAL	E200.7	mg/L	.200	95.2	=	.200	92.2	=	.200	111	=	.200	61.1	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.291	=	.0100	0.816	=	.0100	0.229	=	.0100		ND
SODIUM, TOTAL	E200.7	mg/L	.900	244	=	9.00	513	=	.900	1100	=	.900	188	=
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150	0.026	=	.0150	0.03	=	.0150		ND
LEAD, TOTAL	E200.7	mg/L	.0050		ND	.0050	0.005	=	.0050		ND	.0050		ND
SILICON, TOTAL	E200.7	mg/L	.300	5.56	=	.300	4.95	=	.300	5.01	=	.300	5.44	=
ZINC, TOTAL	E200.7	mg/L	.0100		ND	.0100	0.018	=	.0100		ND	.0100		ND
ALKALINITY	A403	mg/L	10	390	=	10	330	=	10	200	=	10	100	=
COD	A508A	mg/L	5	31	=	5	53	=	5	74	=	5	23	=
FLUORIDE	E340.2	mg/L	0.1	0.2	=	0.1	0.2	=	0.1	0.5	=	0.1		NV
NITRATE/NITRITE	E353.1	mg/L	0.1	0.2	=	0.1		ND	0.1	0.1	=	0.1		ND
AMMONIA	E350.3	mg/L	0.1	0.5	=	0.1	0.7	=	0.1	2.1	=	0.1		HT
TOC	E415.1	mg/L	0.1	4.6	=	0.1	5.4	=	0.1	5.6	=	0.1	4.2	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10	1100	=
	SAMPLE # / RFW # / SAMPLE DATE		05-167-M021 8806-760-003 20-JUN-88			05-231-M021 8806-760-001 20-JUN-88			05-233-M021 8806-760-006 21-JUN-88			05-235-M001 8804-092-008 23-APR-88		
CHLORIDE	A429	mg/L	125	605	=	125	1320	=	125	2360	=	62.5	525	=
SULFATE	A429	mg/L	125	225	=	125	165	=	2.5		ND	2.5	2.9	=
	SAMPLE # / RFW # / SAMPLE DATE		05-167-M021 136805 03-AUG-88			05-231-M021 136804 03-AUG-88			05-233-M021 137011 04-AUG-88			05-235-M021 137012 05-AUG-88		
AMMONIA	E350.3	mg/L										0.1	0.5	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	1800	=	10	2600	=	10	4500	=			

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

Nitrate/nitrite was detected in wells 05-107, 05-167, and 05-233 in low concentrations (0.1 to 0.2 mg/L). Sulfate (2.9 to 260 mg/L) was detected in background concentrations in almost all monitor wells. Chloride concentrations (22.1 to 2,360 mg/L) were above secondary drinking water standards (250 mg/L) in all monitor wells except 05-130 and 05-134. COD (23 to 76 mg/L), alkalinity (100 to 790 mg/L), and TOC (4.2 to 13 mg/L) all were detected in background concentrations for Selfridge ANGB. Groundwater sample 05-134-M001 contained alkalinity at a concentration of 750 mg/L, which is slightly above the background concentration. Ammonia was also detected in low concentrations in all monitor wells (0.5 to 2.1 mg/L). In general, TDS concentrations were elevated (<1,100 mg/L) for all monitor wells at TCLF. The highest concentrations were in monitors wells 05-233 (4,500 mg/L), 05-231 (2,600 mg/L), and 05-105 (2,500 mg/L).

4.8.2.3 Chemical Results for Surface Water -- TCLF

Five surface water sampling stations were established within the stormwater drainage system at TCLF. Station 05-518 was placed at the lift station that pumps water into Lake St. Clair. The other four stations were located in stormwater sewer lines within TCLF. Five investigative surface water samples were collected on 20 April 1988 after an extended dry period, and five investigative surface water samples were collected on 10 May 1988 after a significant rain event.

The surface water samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, COD, TOC, alkalinity, and TDS. Holding times were exceeded for TDS analyses for all surface water samples except sample 05-514-W002. Holding times were exceeded for COD and petroleum hydrocarbons analyses in samples 05-515-W002 and 05-516-W002; for COD analyses in sample 05-514-W002; and for petroleum hydrocarbons analyses for samples 05-517-W002 and 05-518-W002. The surface water stations were resampled on 3 August 1988 (wet event) and on 8 August 1988 (dry event), except for station 05-515, which was dry during both resampling events. No holding times were exceeded for these samples.

Surrogate recoveries ranged from 60 to 113 percent and matrix spike recoveries ranged from 52 to 95 percent for purgeable halocarbons analyses. Surrogate recoveries ranged from 62 to 104 percent and matrix spike recoveries from 97 to 109 percent for purgeable aromatics. Semivolatile surrogate recoveries ranged from 21 to 137 percent, and matrix spike recoveries ranged from 42 to 140 percent. Metals screen matrix spike recoveries ranged from 9.3 to 121 percent. For sample 05-516-W501 matrix spike recoveries were not acceptable for aluminum, boron, calcium, iron, magnesium, manganese, and zinc. For sample 05-516-W502 matrix spike recoveries were not

acceptable for beryllium, iron, and lead. All surrogate recoveries and detection limits were within quality control limits.

In general, surface water stations 05-514 and 05-515 contained the highest concentration values for all analyses. Semi-volatile analyses detected trace (<1 to <3 ug/L) concentrations of the common plasticizers di-n-butyl phthalate and butyl benzyl phthalate in samples 05-515-W001, 05-514-W002, and 05-516-W002. Petroleum hydrocarbons were detected (1.1 to 2.5 mg/L) in all dry-event surface water samples. Petroleum hydrocarbons detections for wet-event samples were invalidated by detections of petroleum hydrocarbons in the corresponding equipment blanks.

Heavy metals were detected in a number of surface water samples, although none exceeded drinking water standards. In general, surface water samples collected during the wet event contained more metals and at higher concentrations than those from the dry event. Samples analyzed from surface water station 05-515 (dry and wet event) contained arsenic (0.005 to 0.012 mg/L), barium (0.354 to 0.385 mg/L), cadmium (0.006 mg/L), chromium (0.017 mg/L), copper (0.029 to 0.031 mg/L), nickel (0.021 mg/L), lead (0.019 to 0.033 mg/L), and zinc (0.108 to 0.036 mg/L). Samples collected from surface water station 05-514 (dry and wet event) contained barium (0.177 to 0.221 mg/L) and cadmium (0.008 mg/L). Samples collected from surface water station 05-516 (dry and wet event) contained barium (0.074 mg/L), copper (0.035 mg/L), lead (0.010 mg/L), and zinc (0.056 to 0.091 mg/L). Samples collected from surface water station 05-517 (dry and wet event) contained copper (0.025 mg/L) and lead (0.028 mg/L). Samples collected from surface water station 05-518 (dry and wet event) contained barium (0.052 mg/L) and copper (0.025 mg/L).

Nitrate/nitrite was detected in low concentrations (0.2 to 0.6 mg/L) in almost every surface water sample collected at TCLF. Sulfate analyses detected concentrations within the background range (5.8 to 105 mg/L) in all surface water samples. Chloride concentrations for the dry and wet events were, in general, elevated in comparison to the rest of the base, with surface water stations 05-514 (800 to 888 mg/L) and 05-515 (1,280 to 1,340 mg/L) containing the highest concentrations detected on base.

TOC was detected in low concentrations in all surface water sampling stations (dry and wet event) at TCLF (6.4 to 5 mg/L). Dry-event alkalinity results were within the background range (180 to 390 mg/L) except for sample 05-514-W001 (530 mg/L). Ammonia was detected in low concentrations (0.2 to 1.8 mg/L) in all surface water samples collected at TCLF. All COD concentrations were within the background range (24 to 76 mg/L), except 05-515-W002, which contained 260 mg/L COD. The COD analysis for 05-515-W002 is for information purposes only, as holding times were exceeded for the initial sample, and the station was dry during the resampling events. TDS analyses

found values above the background range at surface water stations 05-514 (2,000 to 2,500 mg/L) and 05-515 (2,800 to 3,200 mg/L). TDS analyses for station 05-515 are provided for information purposes only, as holding times were exceeded for the initial samples, and the station was dry during the re-sampling events. The TDS concentration in sample 05-517-W001 (560 mg/L) is also above the background range and secondary drinking water standards. Table 4-53 lists the analytical results for all surface water samples (wet and dry event) at TCLF.

4.8.3 Extent of Contamination -- TCLF

Thirty-seven soil samples from 10 soil borings and 9 surface soil samples were retained and analyzed by Clayton Environmental during an environmental assessment of the area directly north of TCLF in 1986 (see Appendix C). Metals analyses detected no heavy metals above the background ranges determined for Selfridge ANGB by the IRP Stage 2 study. However, lead was detected at low levels (3.0 to 12.0 mg/kg) in every Clayton Environmental sample, suggesting a possible background range for lead that is different than that determined by the IRP Stage 2 study due to very few detections (2 out of 62 soil samples). The Clayton Environmental organic analyses detected only trace concentrations of toluene (<0.007 mg/kg). Toluene often occurs naturally at these low levels, and it is also a common laboratory contaminant. The soils north of TCLF, therefore, do not appear to be contaminated.

Chemical analyses of the soils at TCLF during the IRP Stage 2 investigation detected a number of organic contaminants at TCLF. The contaminants included petroleum hydrocarbons (75 to 120 mg/L) and tetrachloroethene, acetone, toluene, 1,1,2,2-tetrachloroethane, ethylbenzene, trichloroethene, and trichlorofluoromethane in trace concentrations (<0.002 to 0.18 mg/L). In addition, samples taken from the top 5 feet of soil boring 05-403 contained several semivolatile organics in trace concentrations (<0.02 to <0.32 mg/L). Although all the borings were placed adjacent to stormwater sewer catch basins, they can be divided geographically into two groups: the soil borings near the school (05-416, 05-417, and 05-421), and those soil borings adjacent to a gravel and cinder road along the northern and eastern perimeters of TCLF (05-401, 05-402, 05-403, 05-404, and 05-405). Except for two detections of acetone in soil borings 05-416 and 05-421 and the detection of 75 mg/kg petroleum hydrocarbons in soil boring 05-417, all the organic contaminants are found in the borings near the gravel and cinder road. The borings closest to the suspected location of the waste pits (the schoolyard) are the least contaminated by organic constituents. This suggests that waste may be buried in the area to the east of Building 970, or that the organic contaminants in these soil borings originated from a source other

TABLE 4-53

VALID ANALYTES DETECTED IN DRY-EVENT SURFACE WATER AT TCLF, IRP STAGE 2, SELFRIDGE ANGB, MI

ANALYTE	SAMPLE # / RFW # / SAMPLE DATE		05-514-W001 128937 20-APR-88			05-515-W001 128938 20-APR-88			05-516-W001 128911 20-APR-88			05-517-W001 128939 20-APR-88			05-518-W001 128940 20-APR-88					
	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
TRANS-1,2-DICHLOROETHENE	E601	ug/L	0.5	.6 (ND)	=	0.5		ND	0.5		ND	0.5		ND	0.5		ND			
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	10	3	<	10		ND	10		ND	10		ND			
DI-N-BUTYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND			
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00	1.1	=	1.01	1.1	=	1.09	2.5	=	1.00	1.5	=	1.12	1.7	=			
ALUMINUM, TOTAL	E200.7	mg/L	.200		ND	.200	3.99	=	.200	0.674	=	.200	0.336	=	.200		ND			
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050	0.005	=	.0050		ND	.0050		ND	.0050		ND			
BORON, TOTAL	E200.7	mg/L	.100	0.116	=	.100	0.118	=	.100	0.159	=	.100		ND	.100	0.122	=			
BARIUM, TOTAL	E200.7	mg/L	.0500	0.177	=	.0500	0.354	=	.0500	0.074	=	.0500		ND	.0500		ND			
CALCIUM, TOTAL	E200.7	mg/L	.200	292	=	.200	346	=	.200	121	=	.200	74.3	=	.200	78.5	=			
CADMIUM, TOTAL	E200.7	mg/L	.0050	0.008	=	.0050		ND	.0050		ND	.0050		ND	.0050		ND			
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND	.0100		ND	.0100		ND	.0100		ND	.0100		ND			
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250	0.029	=	.0250	0.035	=	.0250		ND	.0250		ND			
IRON, TOTAL	E200.7	mg/L	.0400	0.368	=	.0400	8.86	=	.0400	1.09	=	.0400	0.617	=	.0400	0.431	=			
POTASSIUM, TOTAL	E200.7	mg/L	5.00		ND	5.00		ND	5.00		ND	5.00		ND	5.00		ND			
MAGNESIUM, TOTAL	E200.7	mg/L	.200	98	=	.200	104	=	.200	27.7	=	.200	17.8	=	.200	18.8	=			
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.287	=	.0100	0.44	=	.0100	0.219	=	.0100	0.099	=	.0100	0.102	=			
SODIUM, TOTAL	E200.7	mg/L	.900	255	=	9.00	518	=	.900	165	=	.900	87.6	=	.900	87.1	=			
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150		ND	.0150		ND	.0150		ND	.0150		ND			
LEAD, TOTAL	E200.7	mg/L	.0050		ND	.0100	0.019	=	.0050		ND	.0050		ND	.0050		ND			
SILICON, TOTAL	E200.7	mg/L	.300	6.42	=	.300	11.8	=	.300	2.51	=	.300	2.12	=	.300	1.92	=			
ZINC, TOTAL	E200.7	mg/L	.0100		NV	.0100	0.036	=	.0100	0.056	=	.0100	0.012	=	.0100	0.021	=			
ALKALINITY	A403	mg/L	10	530	=	10	390	=	10	200	=	10	180	=	10	190	=			
COD	A508A	mg/L	5	24	=	5	57	=	5		NV	5		NV	5		NV			
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV			
NITRATE/NITRITE	E353.1	mg/L	0.1	0.3	=	0.1	0.2	=	0.1	0.6	=	0.1	0.3	=	0.1	0.4	=			
AMMONIA	E350.3	mg/L	0.1	0.5	=	0.1	1.1	=	0.1	0.8	=	0.1	0.4	=	0.1	0.5	=			
TOC	E415.1	mg/L	1.0	7.4	=	1.0	12	=	1.0	8.3	=	1.0	6.4	=	1.0	7.1	=			
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT	10		HT			

ANALYTE	SAMPLE # / RFW # / SAMPLE DATE		05-514-W001 8804-183-030 20-APR-88		05-515-W001 8804-183-031 20-APR-88		05-516-W001 8804-183-008 20-APR-88		05-517-W001 8804-183-032 20-APR-88		05-518-W001 8804-183-033 20-APR-88	
CHLORIDE	A429	mg/L	62.5	888 =	125	1340 =	25	166 =	25	126 =	25	97.1 =
SULFATE	A429	mg/L	2.5	11.7 =	25	42.2 =	25	56.4 =	2.5	28.2 =	2.5	27.3 =

ANALYTE	SAMPLE # / RFW # / SAMPLE DATE		05-514-W021 137292 08-AUG-88		515 STATION DRY 08-AUG-88		05-516-W021 137293 08-AUG-88		05-517-W021 137294 08-AUG-88		05-518-W021 137295 08-AUG-88		05-518-W121 137296 08-AUG-88	
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	2500 =			10	270 =	10	560 =	10	310 =	10	290 =

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-53 (CONTINUED)

VALID ANALYTES DETECTED IN WET-EVENT SURFACE WATER AT TCLF

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE # / RFW # / SAMPLE DATE		05-514-W002 130199 10-MAY-88			05-515-W002 130200 10-MAY-88			05-516-W002 130201 10-MAY-88			05-517-W002 130204 10-MAY-88			05-518-W002 130205 10-MAY-88					
TRANS-1,2-DICHLOROETHENE	E601	ug/L	0.5	1.4 (ND)	=	0.5		ND	0.5		ND	0.5		ND	0.5		ND			
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND			
DI-N-BUTYL PHTHALATE	E625	ug/L	10	2	<	10		ND	10	1	<	10		ND	10		ND			
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.02		NV	1.04		HT	1.00		HT	1.02		HT	1.02		HT			
ALUMINUM, TOTAL	E200.7	mg/L	.200		ND	.200	11.2	=	.200	1.26	=	.200	0.602	=	.200	0.63	=			
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050	0.012	=	.0050		ND	.0050		ND	.0050		ND			
BORON, TOTAL	E200.7	mg/L	.100	0.119	=	.100	0.102	=	.100		ND	.100	0.112	=	.100		ND			
BARIUM, TOTAL	E200.7	mg/L	.0500	0.221	=	.0500	0.385	=	.0500		ND	.0500	0.102	=	.0500	0.052	=			
CALCIUM, TOTAL	E200.7	mg/L	.200	310	=	.200	344	=	.200	55.6	=	.200	177	=	.200	69.3	=			
CADMIUM, TOTAL	E200.7	mg/L	.0050		ND	.0050	0.006	=	.0050		ND	.0050		ND	.0050		ND			
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND	.0100	0.017	=	.0100		ND	.0100		ND	.0100		ND			
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250	0.031	=	.0250		ND	.0250	0.025	=	.0250	0.025	=			
IRON, TOTAL	E200.7	mg/L	.0400	1.24	=	.0400	16.7	=	.0400	1.54	=	.0400	2.02	=	.0400	0.947	=			
POTASSIUM, TOTAL	E200.7	mg/L	5.00		ND	5.00	6	=	5.00		ND	5.00		ND	5.00		ND			
MAGNESIUM, TOTAL	E200.7	mg/L	.200	111	=	.200	104	=	.200	12.6	=	.200	41.6	=	.200	16	=			
MANGANESE, TOTAL	E200.7	mg/L	.0100	1.46	=	.0100	1.49	=	.0100	0.19	=	.0100	0.41	=	.0100	0.201	=			
SODIUM, TOTAL	E200.7	mg/L	9.00	275	=	9.00	549	=	.900	117	=	.900	144	=	.900	137	=			
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150	0.021	=	.0150		ND	.0150		ND	.0150		ND			
LEAD, TOTAL	E200.7	mg/L	.0050		ND	.0100	0.033	=	.0100	0.01	=	.0100	0.028	=	.0050		ND			
SILICON, TOTAL	E200.7	mg/L	.300	7.97	=	.300	23.5	=	.300	4.22	=	.300	5.1	=	.300	3.08	=			
ZINC, TOTAL	E200.7	mg/L	.0100	0.017	=	.0100	0.108	=	.0100	0.091	=	.0100	0.039	=	.0100	0.041	=			
ALKALINITY	A403	mg/L	10		NV	10		NV	10		NV	10		NV	10		NV			
COD	A508A	mg/L	5		HT	5		HT	5		HT	5		NV	5		NV			
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV	0.1		NV			
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1	0.3	=	0.1	0.6	=	0.1	0.4	=	0.1	0.5	=			
AMMONIA	E350.3	mg/L	0.1	1.8	=	0.1	1	=	0.1	0.4	=	0.1	0.3	=	0.1	0.2	=			
TOC	E415.1	mg/L	1.0	15	=	1.0	8	=	1.0	8.5	=	1.0	8.8	=	1.0	6.4	=			
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	2000	=	10		HT	10		HT	10		HT	10		HT			
	SAMPLE # / RFW # / SAMPLE DATE		05-514-W002 8805-386-011 10-MAY-88			05-515-W002 8805-386-012 10-MAY-88			05-516-W002 8805-386-014 10-MAY-88			05-517-W002 8805-386-017 10-MAY-88			05-518-W002 8805-386-018 10-MAY-88					
CHLORIDE	A429	mg/L	62.5	800	=	125	1280	=	62.5	245	=	62.5	150	=	62.5	248	=			
SULFATE	A429	mg/L	2.5	21.1	=	62.5	102	=	2.5	49.6	=	62.5	105	=	2.5	5.8	=			
	SAMPLE # / RFW # / SAMPLE DATE		05-514-W022 136830 03-AUG-88			515 STATION DRY 03-AUG-88			05-516-W022 136831 03-AUG-88			05-517-W022 136837 03-AUG-88			05-518-W022 136838 03-AUG-88			05-516-W122 136832 03-AUG-88		
COD	A508A	mg/L	5	76	=				5	29	=							5	26	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L							10	270	=	10	170	=	10	190	=	10	210	=
PETROLEUM HYDROCARBONS	E418.1	mg/L							1.02		NV	1.01		NV	1.01		NV			

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

than buried waste. A plausible source may be fuel leaks that have occurred or tar or oil placed on the gravel and cinder road at the site. In addition, a pile of old railroad ties is located in a clump of trees between soil borings 05-403 and 05-405, near the gravel road. The railroad ties may be a possible source of the observed semivolatile contamination. The boat marina near soil boring 05-405 may also be a source of petroleum hydrocarbons contamination due to motor boat fuels and oil. Therefore, the soil borings do not conclusively indicate any contamination from the waste buried at TCLF.

Although all metals concentrations were within the naturally occurring ranges observed for these elements in the eastern conterminous United States (USGS Professional Paper 1270), several heavy metals including arsenic (43.2 mg/kg), copper (34.2, 38.9, and 44.1 mg/kg), lead (22.5 and 82.2 mg/kg), and zinc (74.9, 76.3, and 95.6 mg/kg) were detected at levels above base background. These values were detected primarily in soil borings 05-401, 05-402, and 05-403 along the gravel and cinder road. The two lower values of zinc cited were detected in soil borings 05-416 and 05-417.

Clayton Environmental's assessment (see Appendix C) at TCLF sampled and analyzed eight groundwater samples for metals, total hydrocarbons, cyanide, sulfide, semivolatile organic compounds, volatile organic compounds, pesticides, PCBs, and explosives. Two of these groundwater samples are not considered valid because the monitor wells were not properly purged due to slow recharge. Trace concentrations of heavy metals were detected in the remaining six groundwater samples, including barium, arsenic, chromium, copper, lead, mercury, selenium, and zinc. None of the concentrations were in excess of the primary drinking water standards. All other analyses were negative. Therefore, the groundwater in the area north of TCLF does not appear to be contaminated.

The Phase II Stage 1 investigation sampled three monitor wells (05-105, 05-106, and 05-107) for groundwater. Trichloroethene (2.2 to 3.1 ug/L) was detected in all three monitor wells. In addition, COD (194 to 688 mg/L) and oil and grease (0.44 to 1.17 mg/L) were above background for all three monitor wells. Monitor well 05-105 contained cadmium (0.014 mg/L), lead (0.044 mg/L), and copper (1.90 mg/L).

The IRP Stage 2 investigation confirmed the presence of trichloroethene (4.1 ug/L) and also identified benzene (2 ug/L) in monitor well 05-107. Methylene chloride (2 ug/L) was detected in monitor well 05-105 and 1,4-dichlorobenzene (<2 ug/L) in well 05-167 (replacement well for 05-106). Petroleum hydrocarbons (1 to 4.1 mg/L) were detected in monitor wells 05-105, 05-167, 05-132, 05-233, and 05-231. Except for monitor well 05-105, all of these wells are located near the boat marina, a possible source of hydrocarbons contamination. TDS (1,100 to 4,500 mg/L), chloride (22.1 to 2,360 mg/L), and sulfate (13.5 to 260 mg/L) were elevated for most monitor wells at TCLF. All

of the TDS concentrations and most of chloride concentrations exceeded secondary drinking water standards. Alkalinity was elevated for monitor well 05-134. Trace metals concentrations of barium, cadmium, copper, nickel, lead, and zinc also occurred (0.011 to 0.929 mg/L) in these monitor wells. None of the metal concentrations exceeded primary or secondary drinking water standards. The elevated indicator parameters (anions) and metals concentrations (cations) are characteristic of landfill leachate. It appears that the groundwater is, therefore, slightly contaminated by the wastes buried at TCLF. The exact location of the buried waste is not identifiable; however, it appears to be restricted to the originally identified extent of TCLF.

Groundwater migration away from TCLF is restricted by the stormwater drainage network that truncates the water table, resulting in a groundwater sink in the eastern portion of TCLF. Potentiometric surface maps define the groundwater sink as a north-south trough for both deep and shallow monitor well systems. The result of this trough is that groundwater flows toward the center of TCLF from the east and west, thereby restricting migration of contaminants away from TCLF. It appears that the only means for contaminants to be transported away from TCLF is by interception of contaminated groundwater by the stormwater drainage system.

Surface water was not sampled during the Phase II Stage 1 investigation at TCLF. The IRP Stage 2 investigation found that surface water at stormwater sampling stations 05-514 and 05-515 contained elevated chloride (800 to 1,340 mg/L), TDS (2,000 to 3,200 mg/L), arsenic, barium, cadmium, chromium, copper, nickel, lead, and zinc. None of the metals concentrations exceeded primary or secondary drinking water standards. The location of these two sampling stations near roadways suggest that salt application during winter months may be responsible for the elevated chloride and TDS values. Both of these sampling stations were located in upgradient sections of the stormwater system that drains TCLF. The downgradient sampling stations (05-516, 05-517, and 05-518) were much less contaminated, indicating dilution is reducing the concentrations of these contaminants. Petroleum hydrocarbons were detected in all dry- and wet-event surface water samples. Results of the wet-event petroleum hydrocarbons detections were invalidated because of detections in the equipment blanks.

No analyte concentrations exceeding applicable standards were detected in soil at TCLF. The organic analytes butyl benzyl phthlate, bis(2-ethylhexyl) phthalate, and di-n-butyl phthalate exceeded the standards under potential international chemical-specific ARARs for groundwater. Trichloroethene and benzene also exceeded the proposed RCRA media protection standards and Safe Drinking Water Act standards (see Table 4-54).

Table 4-54

Analyte Concentrations in TCLF Groundwater Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Trichloroethene		N/A	3.2×10^{-4}	N/A	N/A	N/A	N/A
05-107-M001	4.1×10^{-3}	---	X	---	---	---	---
Benzene		N/A	N/A	N/A	N/A	N/A	N/A
05-107-M001	2×10^{-3}	---	---	---	---	---	---
Butyl benzyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
05-105-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
05-235-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
Bis(2-ethylhexyl) phthalate		6×10^{-4}	N/A	N/A	N/A	N/A	N/A
05-105-M001	$<4 \times 10^{-3}$	X	---	---	---	---	---
05-107-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
05-132-M001	$<4 \times 10^{-3}$	X	---	---	---	---	---
05-134-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
05-167-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
05-231-M001	$<4 \times 10^{-3}$	X	---	---	---	---	---
05-233-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
05-235-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
Di-n-butyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
05-107-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
05-130-M101	$<1 \times 10^{-3}$	X	---	---	---	---	---
05-167-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
05-233-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-54
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Trichloroethene		N/A	N/A	0	N/A	N/A
05-107-M001	4.1×10^{-3}	---	---	X	---	---
Benzene		N/A	N/A	0	N/A	0
05-107-M001	2×10^{-3}	---	---	X	---	X
Butyl benzyl phthalate		N/A	N/A	N/A	N/A	N/A
05-105-M001	$<1 \times 10^{-3}$	---	---	---	---	---
05-235-M001	$<1 \times 10^{-3}$	---	---	---	---	---
Bis(2-ethylhexyl) phthalate		N/A	N/A	N/A	N/A	N/A
05-105-M001	$<4 \times 10^{-3}$	---	---	---	---	---
05-107-M001	$<1 \times 10^{-3}$	---	---	---	---	---
05-132-M001	$<4 \times 10^{-3}$	---	---	---	---	---
05-134-M001	$<2 \times 10^{-3}$	---	---	---	---	---
05-167-M001	$<2 \times 10^{-3}$	---	---	---	---	---
05-231-M001	$<4 \times 10^{-3}$	---	---	---	---	---
05-233-M001	$<2 \times 10^{-3}$	---	---	---	---	---
05-235-M001	$<1 \times 10^{-3}$	---	---	---	---	---
Di-n-butyl phthalate		N/A	N/A	N/A	N/A	N/A
05-107-M001	$<2 \times 10^{-3}$	---	---	---	---	---
05-130-M101	$<1 \times 10^{-3}$	---	---	---	---	---
05-167-M001	$<1 \times 10^{-3}$	---	---	---	---	---
05-233-M001	$<2 \times 10^{-3}$	---	---	---	---	---

X = Standard execeeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-54
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Arsenic		N/A	N/A	N/A	N/A	N/A	2.2×10^{-5}
05-235-M001	7×10^{-3}	---	---	---	---	---	X
Beryllium		N/A	N/A	N/A	1.3×10^{-1}	5.3×10^{-3}	3.7×10^{-5}
05-235-M001	4.12×10^{-1}	---	---	---	X	X	X
Cadmium		2.0×10^{-4}	N/A	N/A	3.9×10^{-3}	1.1×10^{-3}	N/A
05-107-M001	6×10^{-3}	X	---	---	X	X	---
05-130-M101	6×10^{-3}	X	---	---	X	X	---
05-167-M001	8×10^{-3}	X	---	---	X	X	---
05-233-M001	8×10^{-3}	X	---	---	X	X	---
Copper		5.0×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
05-167-M001	2.6×10^{-2}	X	---	---	X	X	---
05-233-M001	3×10^{-2}	X	---	---	X	X	---
Nickel		2.5×10^{-2}	N/A	N/A	N/A	N/A	1.34×10^{-2}
05-107-M001	2.5×10^{-2}	X	---	---	---	---	X
05-132-M001	5.5×10^{-2}	X	---	---	---	---	X
05-134-M001	4.5×10^{-2}	X	---	---	---	---	X
05-231-M001	2.6×10^{-2}	X	---	---	---	---	X
Lead		N/A	N/A	N/A	N/A	3.2×10^{-3}	N/A
05-231-M001	5×10^{-3}	---	---	---	---	X	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-54
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Arsenic		2.5×10^{-5}	N/A	N/A	N/A	N/A
05-235-M001	7×10^{-3}	X	---	---	---	---
Beryllium		3.9×10^{-5}	N/A	N/A	N/A	N/A
05-235-M001	4.12×10^{-1}	X	---	---	---	---
Cadmium		N/A	N/A	N/A	5×10^{-3}	5×10^{-3}
05-107-M001	6×10^{-3}	---	---	---	X	X
05-130-M101	6×10^{-3}	---	---	---	X	X
05-167-M001	8×10^{-3}	---	---	---	X	X
05-233-M001	8×10^{-3}	---	---	---	X	X
Copper		N/A	N/A	N/A	N/A	N/A
05-167-M001	2.6×10^{-2}	---	---	---	---	---
05-233-M001	3×10^{-2}	---	---	---	---	---
Nickel		1.54×10^{-2}	N/A	N/A	N/A	N/A
05-107-M001	2.5×10^{-2}	X	---	---	---	---
05-132-M001	5.5×10^{-2}	X	---	---	---	---
05-134-M001	4.5×10^{-2}	X	---	---	---	---
05-231-M001	2.6×10^{-2}	X	---	---	---	---
Lead		N/A	N/A	N/A	N/A	0
05-231-M001	5×10^{-3}	---	---	---	---	X

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-54
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Ammonia		5.0×10^{-1}	N/A	N/A	N/A	N/A	N/A
05-107-M001	1.6	X	---	---	---	---	---
05-130-M001	8×10^{-1}	X	---	---	---	---	---
05-130-M101	7×10^{-1}	X	---	---	---	---	---
05-134-M001	7×10^{-1}	X	---	---	---	---	---
05-167-M001	5×10^{-1}	X	---	---	---	---	---
05-132-M001	5×10^{-1}	X	---	---	---	---	---
05-231-M001	7×10^{-1}	X	---	---	---	---	---
05-233-M001	2.1	X	---	---	---	---	---
05-105-M021	1.3	X	---	---	---	---	---
IDS		2.0×10^{2}	N/A	N/A	N/A	N/A	N/A
05-105-M001	2.5×10^{3}	X	---	---	---	---	---
05-107-M021	1.8×10^{3}	X	---	---	---	---	---
05-130-M021	1.7×10^{3}	X	---	---	---	---	---
05-107-M121	1.9×10^{3}	X	---	---	---	---	---
05-132-M021	2.0×10^{3}	X	---	---	---	---	---
05-134-M001	1.1×10^{3}	X	---	---	---	---	---
05-167-M021	1.8×10^{3}	X	---	---	---	---	---
05-231-M021	2.6×10^{3}	X	---	---	---	---	---
05-233-M021	4.5×10^{3}	X	---	---	---	---	---
05-235-M021	1.1×10^{3}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-54
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Ammonia		N/A	N/A	N/A	N/A	N/A
05-107-M001	1.6	---	---	---	---	---
05-130-M001	8×10^{-1}	---	---	---	---	---
05-130-M101	7×10^{-1}	---	---	---	---	---
05-134-M001	7×10^{-1}	---	---	---	---	---
05-167-M001	5×10^{-1}	---	---	---	---	---
05-132-M001	5×10^{-1}	---	---	---	---	---
05-231-M001	7×10^{-1}	---	---	---	---	---
05-233-M001	2.1	---	---	---	---	---
05-105-M021	1.3	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
05-105-M001	2.5×10^{3}	---	---	---	---	---
05-107-M021	1.8×10^{3}	---	---	---	---	---
05-130-M021	1.7×10^{3}	---	---	---	---	---
05-107-M121	1.9×10^{3}	---	---	---	---	---
05-132-M021	2.0×10^{3}	---	---	---	---	---
05-134-M001	1.1×10^{3}	---	---	---	---	---
05-167-M021	1.8×10^{3}	---	---	---	---	---
05-231-M021	2.6×10^{3}	---	---	---	---	---
05-233-M021	4.5×10^{3}	---	---	---	---	---
05-235-M021	1.1×10^{3}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Inorganic analytes in groundwater exceeding standards were arsenic, beryllium, cadmium, copper, nickel, lead, ammonia, and TDS (see Table 4-54). The arsenic concentration in sample 05-235-M001 was above the standard for the EPA ambient water quality criteria. Cadmium concentrations in several samples (see Table 4-54) were above standards for potential international chemical-specific ARARs, Clean Water Act freshwater toxicity criterion, and the Safe Drinking Water Act proposed standards.

Analyte concentrations in surface water samples (dry and wet event) exceeded similar standards as those for groundwater (see Table 4-55). Organic analytes were in exceedance of the potential international chemical-specific ARARs. Cadmium, copper, nickel, and lead concentrations exceeded the potential international chemical-specific ARARs, Clean Water Act standards, EPA ambient water quality criteria, and Safe Drinking Water Act standards (see Table 4-55).

4.8.4 Qualitative Risk Assessment -- TCLF

Fifty-four individual chemical species were identified in subsurface soil, groundwater, and surface water samples collected at TCLF. Of these 54, 27 contaminants of concern were identified using the EPA indicator chemical selection process. These contaminants include phthalates, PAHs, metals, chlorinated olefins, and other volatile/semivolatile species. The contaminants of concern for the TCLF are listed in Table 4-56.

The following migration pathways for movement of contaminants from the TCLF site have been identified:

- Soil --> groundwater.
- Soil --> groundwater --> stormwater drainage system --> surface water.

At the present time access to this site is not restricted. It is estimated that more than 100 persons are located within 1,000 feet of the site perimeter on a day-to-day basis. The majority of these people are in the base school that is located on the southern edge of the site. The access problem is further compounded by the possibility that a fenced play area on the northern side of the school may, in part, overlap the former landfill site. This has not been confirmed by base records or environmental sampling at this site.

Surface water samples were collected at the site from the stormwater drainage system. Contaminants found in samples included phthalates, nickel, and ammonia. No contaminants detected in surface water samples were present at levels that

Table 4-55

Analyte Concentrations in TCLF Surface Water Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Di-n-butyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
05-514-W002	$<2 \times 10^{-3}$	X	---	---	---	---	---
05-515-W002	$<1 \times 10^{-3}$	X	---	---	---	---	---
Butyl benzyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
05-515-W001	$<3 \times 10^{-3}$	X	---	---	---	---	---
Arsenic		N/A	N/A	N/A	N/A	N/A	2.2×10^{-5}
05-515-W001	5×10^{-3}	---	---	---	---	---	X
05-515-W002	1.2×10^{-2}	---	---	---	---	---	X
Cadmium		2×10^{-4}	N/A	N/A	3.9×10^{-3}	1.1×10^{-3}	1×10^{-2}
05-514-W001	8×10^{-3}	X	---	---	X	X	---
05-515-W002	5×10^{-3}	X	---	---	X	X	---
Copper		5×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
05-515-W001	2.9×10^{-2}	X	---	---	X	X	---
05-516-W001	3.5×10^{-2}	X	---	---	X	X	---
05-515-W002	3.1×10^{-2}	X	---	---	X	X	---
05-517-W002	2.5×10^{-2}	X	---	---	X	X	---
05-518-W002	2.5×10^{-2}	X	---	---	X	X	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-55
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Di-n-butyl phthalate		N/A	N/A	N/A	N/A	N/A
05-514-W002	$<2 \times 10^{-3}$	---	---	---	---	---
05-515-W002	$<1 \times 10^{-3}$	---	---	---	---	---
Butyl benzyl phthalate		N/A	N/A	N/A	N/A	N/A
05-515-W001	$<3 \times 10^{-3}$	---	---	---	---	---
Arsenic		2.5×10^{-5}	N/A	N/A	N/A	N/A
05-515-W001	5×10^{-3}	X	---	---	---	---
05-515-W002	1.2×10^{-2}	X	---	---	---	---
Cadmium		1.2×10^{-2}	N/A	N/A	5.0×10^{-3}	5.0×10^{-3}
05-514-W001	8×10^{-3}	X	---	---	X	X
05-515-W002	5×10^{-3}	X	---	---	X	X
Copper		N/A	N/A	N/A	N/A	N/A
05-515-W001	2.9×10^{-2}	---	---	---	X	X
05-516-W001	3.5×10^{-2}	---	---	---	X	X
05-515-W002	3.1×10^{-2}	---	---	---	X	X
05-517-W002	2.5×10^{-2}	---	---	---	X	X
05-518-W002	2.5×10^{-2}	---	---	---	X	X

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-55
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Iron		3×10^{-1}	N/A	N/A	N/A	N/A	N/A
05-514-W001	3.68×10^{-1}	X	---	---	---	---	---
05-515-W001	8.86	X	---	---	---	---	---
05-516-W001	1.09	X	---	---	---	---	---
05-517-W001	6.17×10^{-1}	X	---	---	---	---	---
05-518-W001	4.31×10^{-1}	X	---	---	---	---	---
05-514-W002	1.24	X	---	---	---	---	---
05-514-W002	1.67×10^{1}	X	---	---	---	---	---
05-516-W002	1.54	X	---	---	---	---	---
05-517-W002	2.02	X	---	---	---	---	---
05-518-W002	9.47×10^{-1}	X	---	---	---	---	---
Nickel		N/A	N/A	N/A	N/A	N/A	1.34×10^{-2}
05-515-W002	2.1×10^{-2}	---	---	---	---	---	X
Lead		2.5×10^{-2}	N/A	N/A	N/A	3.2×10^{-3}	N/A
05-515-W001	1.9×10^{-2}	---	---	---	---	X	---
05-515-W002	3.3×10^{-2}	X	---	---	---	X	---
05-516-W002	1×10^{-2}	---	---	---	---	X	---
05-517-W002	2.8×10^{-2}	X	---	---	---	X	---
Zinc		3×10^{-2}	N/A	N/A	N/A	N/A	N/A
05-515-W001	3.6×10^{-2}	X	---	---	---	---	---
05-516-W001	5.6×10^{-2}	X	---	---	---	---	---
05-515-W002	1.08×10^{-1}	X	---	---	---	---	---
05-516-W002	9.1×10^{-2}	X	---	---	---	---	---
05-517-W002	3.9×10^{-2}	X	---	---	---	---	---
05-518-W002	4.1×10^{-2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-55
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Iron		N/A	N/A	N/A	N/A	N/A
05-514-W001	3.68×10^{-1}	---	---	---	---	---
05-515-W001	8.86	---	---	---	---	---
05-516-W001	1.09	---	---	---	---	---
05-517-W001	6.17×10^{-1}	---	---	---	---	---
05-518-W001	4.31×10^{-1}	---	---	---	---	---
05-514-W002	1.24	---	---	---	---	---
05-514-W002	1.67×10^{1}	---	---	---	---	---
05-516-W002	1.54	---	---	---	---	---
05-517-W002	2.02	---	---	---	---	---
05-518-W002	9.47×10^{-1}	---	---	---	---	---
Nickel		1.54×10^{-2}	N/A	N/A	N/A	N/A
05-515-W002	2.1×10^{-2}	X	---	---	---	---
Lead		N/A	N/A	N/A	N/A	0
05-515-W001	1.9×10^{-2}	---	---	---	---	X
05-515-W002	3.3×10^{-2}	---	---	---	---	X
05-516-W002	1×10^{-2}	---	---	---	---	X
05-517-W002	2.8×10^{-2}	---	---	---	---	X
Zinc		N/A	N/A	N/A	N/A	N/A
05-515-W001	3.6×10^{-2}	---	---	---	---	---
05-516-W001	5.6×10^{-2}	---	---	---	---	---
05-515-W002	1.08×10^{-1}	---	---	---	---	---
05-516-W002	9.1×10^{-2}	---	---	---	---	---
05-517-W002	3.9×10^{-2}	---	---	---	---	---
05-518-W002	4.1×10^{-2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-55
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Ammonia		5×10^{-1}	N/A	N/A	N/A	N/A	N/A
05-514-W001	5×10^{-1}	X	---	---	---	---	---
05-515-W001	1.1	X	---	---	---	---	---
05-516-W001	8×10^{-1}	X	---	---	---	---	---
05-518-W001	5×10^{-1}	X	---	---	---	---	---
05-514-W002	1.8	X	---	---	---	---	---
05-515-W002	1.0	X	---	---	---	---	---
TDS		2.0×10^{2}	N/A	N/A	N/A	N/A	N/A
05-514-W021	2.5×10^{3}	X	---	---	---	---	---
05-516-W021	2.7×10^{2}	X	---	---	---	---	---
05-517-W021	5.6×10^{2}	X	---	---	---	---	---
05-518-W021	3.1×10^{2}	X	---	---	---	---	---
05-518-W121	2.9×10^{2}	X	---	---	---	---	---
05-514-W002	2.0×10^{3}	X	---	---	---	---	---
05-516-W002	2.7×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-55
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Ammonia		N/A	N/A	N/A	N/A	N/A
05-514-W001	5×10^{-1}	---	---	---	---	---
05-515-W001	1.1	---	---	---	---	---
05-516-W001	8×10^{-1}	---	---	---	---	---
05-518-W001	5×10^{-1}	---	---	---	---	---
05-514-W002	1.8	---	---	---	---	---
05-515-W002	1.0	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
05-514-W021	2.5×10^{3}	---	---	---	---	---
05-516-W021	2.7×10^{2}	---	---	---	---	---
05-517-W021	5.6×10^{2}	---	---	---	---	---
05-518-W021	3.1×10^{2}	---	---	---	---	---
05-518-W121	2.9×10^{2}	---	---	---	---	---
05-514-W002	2.0×10^{3}	---	---	---	---	---
05-516-W002	2.7×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-56

Contaminants of Concern at TCLF, IRP Stage 2, Selfridge ANGB, MI

Contaminant	Maximum Concentration Detected in Medium: Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
Acetone[a]	0.00018		
Ammonia[a]		2.1	1.8
Toluene	0.00002		
Nickel[b]	0.0405	0.057	0.021
Carbon disulfide[a]	0.000004		
1,4-Dichlorobenzene		0.002	
Benzene[c]		0.002[d]	
Beryllium[b]	0.0012	0.000412[d]	
1,1,1-Trichloroethane	0.000041		
Tetrachloroethene[c]	0.000002		
trans-1,2-Dichloroethene			0.0014
Trichloroethene[c]	0.000002		
Methylene chloride[a]		0.002	
PAHs			
Benzo(a)anthracene[c]	0.00013		
Benzo(a)pyrene[c]	0.00012		
Benzo(b)fluoranthene[c]	0.00012		
Benzo(g,h,i)perylene	0.0001		
Benzo(k)fluoranthene[c]	0.00011		
Chrysene[b]	0.00015		
Fluoranthene	0.00032		
Dibenzo(a,h)anthracene[c]	0.00011		
Anthracene	0.00002		
Phenanthrene	0.00015		
Pyrene	0.00029		
Phthalates			
Bis(2-ethylhexyl) phthalate		0.004	
Butyl benzyl phthalate[a]		0.001	0.003
Di-n-butyl phthalate		0.002	0.002

[a]No Federal or state criteria exist at present for contaminant levels in groundwater or surface water.
[b]Known/suspected carcinogen (inhalation route).
[c]Known/suspected carcinogen (oral route).
[d]Exceeds EPA ambient water quality criteria for the protection of human health.

exceeded water quality standards or recommendations. Thus, the contaminant contribution of site stormwater drainage to base-wide discharge to Lake St. Clair is not significant.

Higher concentrations of these contaminants as well as other contaminants were detected in site groundwater samples. The maximum concentrations of benzene and beryllium detected in groundwater samples from the site exceeded EPA ambient water quality criteria for the protection of human health. Although direct contact with groundwater by use of well water is not a potential exposure pathway on the base, seepage of contaminated groundwater into the stormwater drainage system does occur. Receptors could contact any contaminants at the point of discharge into Lake St. Clair.

The exposure pathway of most concern at TCLF is direct contact with contaminated soils, with subsequent dermal contact or inadvertent ingestion of contaminated soils. However, exposure to base personnel is not considered significant because of limited activity at the site and the fact that the landfill wastes are covered. Contaminants in the soils are subsurface and do not represent a direct contact hazard. However, if the fenced school play area does overlap a portion of the landfill, an uncharacterized area exists. Therefore, the depth of cover over landfilled materials and the extent of contamination of soils in this area must be determined.

The contaminants of primary concern in soils are the PAHs, some of which are known or suspected carcinogens by oral or dermal exposure routes.

4.9 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- NORTHWEST LANDFILL

4.9.1 Pathway Characterization and Migration Potential -- NWLF

4.9.1.1 Subsurface Conditions -- NWLF

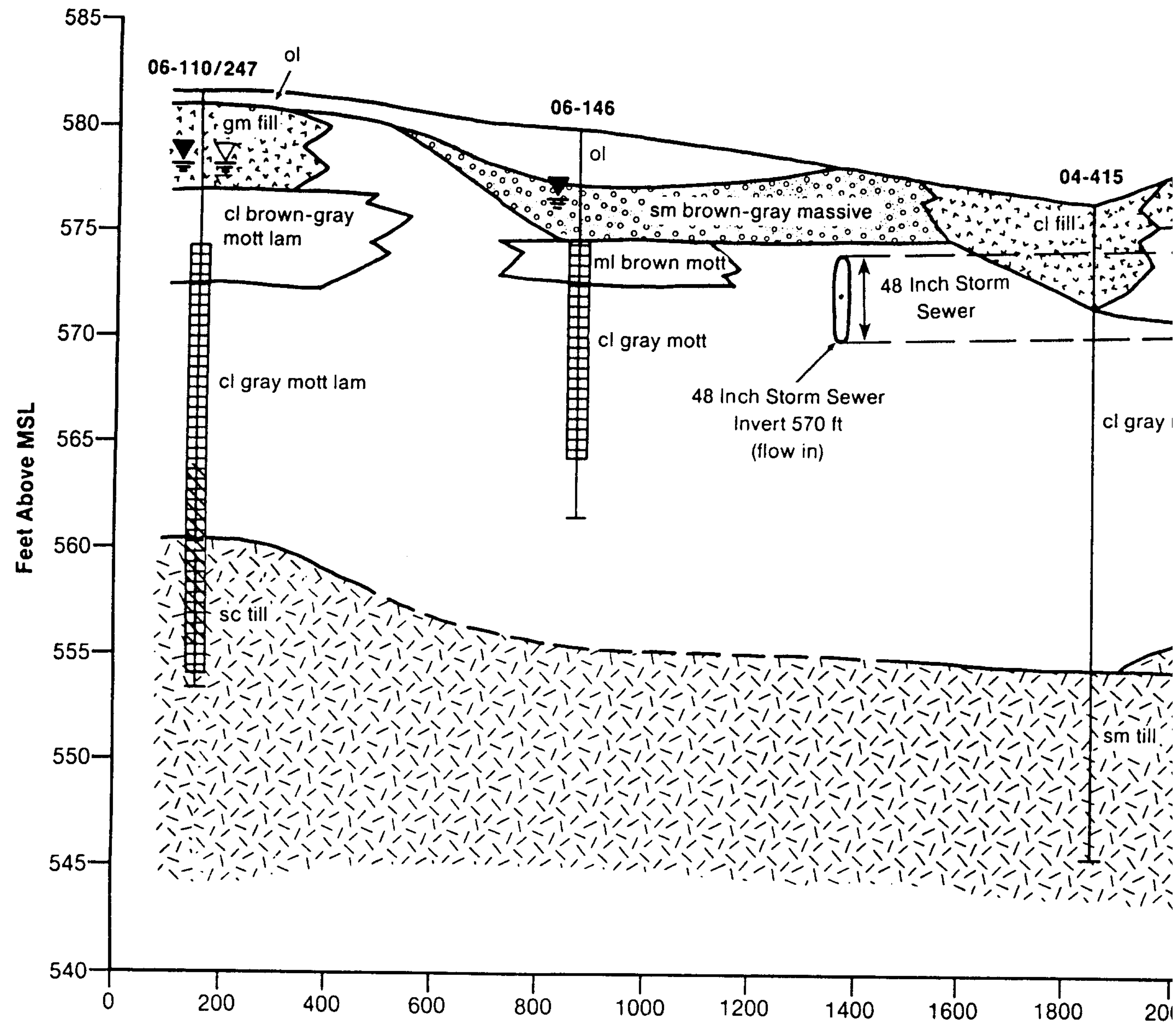
Surficial soils at NWLF as mapped by the USDA Soil Survey (see Figure 2-5) predominantly consist of the Toledo Series. The Brevort and Au Gres soils comprise the remainder. These soils are developed from a silty clay loam to a lacustrine clay parent material. Sand layers are also found in these soils. In the central portion of NWLF, trending in a northeast to southwest direction, is an area of Made Land (Md). This represents the location for a borrow pit. Sand was removed from this pit and used in construction activities on the base. Based upon an examination of aerial photographs taken of NWLF, the general location of the landfill at the site appears to correspond to the area mapped as Made Land.

Information from four monitor well borings installed during this study in combination with logs made of well borings installed during the IRP Phase II Stage 1 study provided a means to assess the shallow subsurface geology. The site stratigraphy of NWLF, shown in Figures 4-58, 4-59, and 4-60, is dominated by a gray clay to silty clay to a depth of 32 feet. Figure 4-61 shows the trace of the cross sections. The information regarding the upper 5 feet of NWLF is limited because less than 25 percent of the soil samples were recovered for this interval in 3 of the 4 monitor well borings. Based upon the limited amount of soil recovered, this upper interval consists of a fill material comprised of clay and silt down to a depth of approximately 3.5 feet. This clay is underlain by a brown silty sand, which may also be fill material.

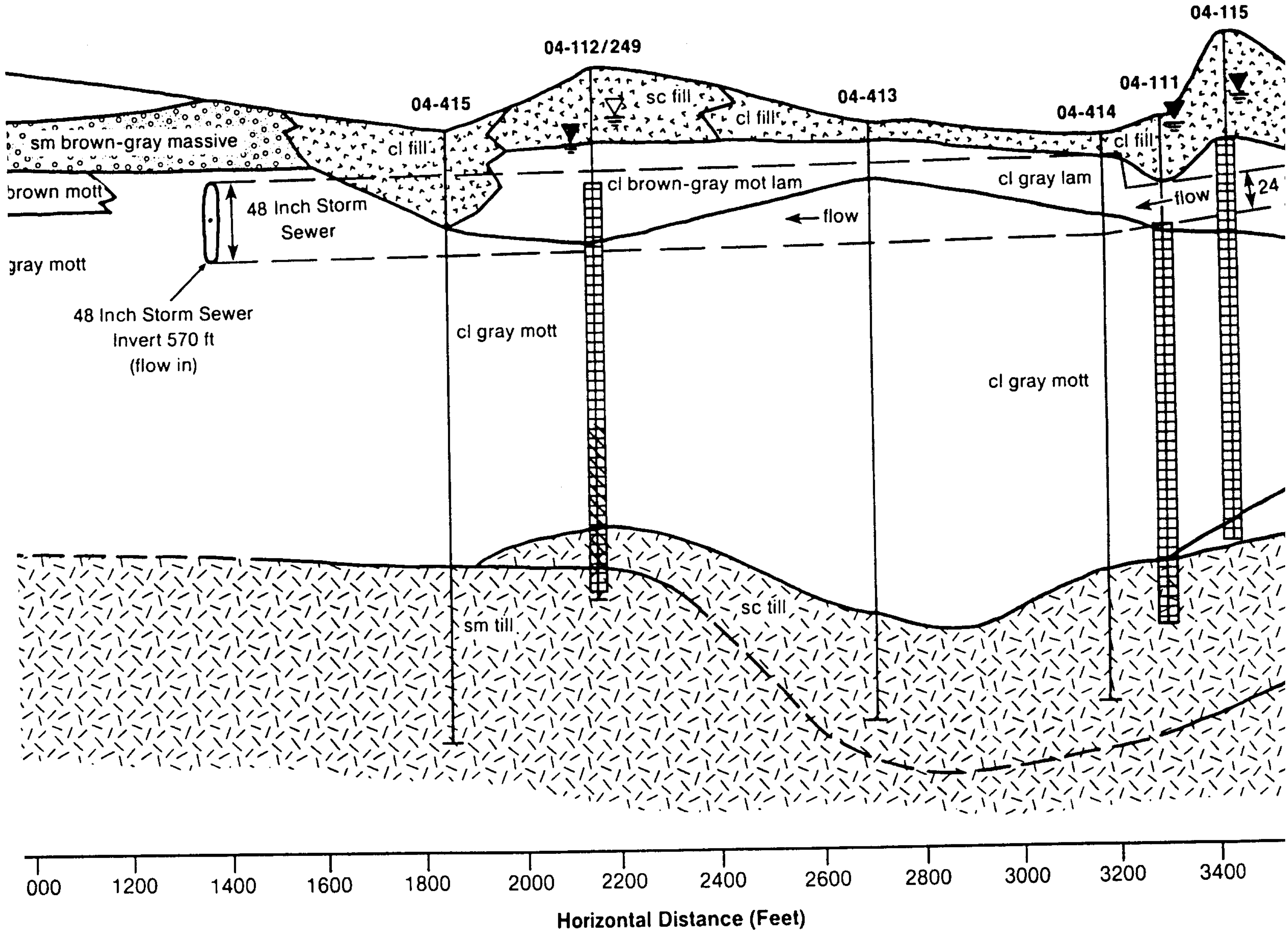
Below a depth of 5 feet a gray silty clay to clay was encountered to a depth of 32 feet. The upper portion of this unit contains thin sand stringers and occasional mottling. The boring for monitor well 06-247 contained a gray clayey sand to sandy clay from 20 to 25 feet and a hard clayey sand from 28 to 30 feet.

Four IRP Stage 2 monitor wells with 10-foot screens were installed. Monitor well 06-245 was screened in gray clay to silty clay and the underlying gravelly silt. Monitor well 06-247 was screened in gray clay to silty clay and the underlying sandy clay to clayey sand. Monitor well 06-144 was screened in the hard silty clay and brown sand that overly the gray silty clay. Monitor well 06-146 was screened in brown silty clay to clayey silt and the underlying gray silty clay. No waste materials were encountered at any of the monitor well borings.

North A



585
580
575
570
565
560
555
550
545
540
Feet Above MSL
06-110/247
ol
gm fill
cl brown-gray mott lam
cl gray mott lam
sc till
06-146
ol
sm brown-gray massive
ml brown mott
cl gray mott
48 Inch Storm Sewer
48 Inch Storm Sewer Invert 570 ft (flow in)
04-415
cl fill
cl gray
sm till
0
200
400
600
800
1000
1200
1400
1600
1800


04-115
04-112/249
04-111
04-415
04-413
04-414
sc fill
cl fill
sm brown-gray massive
cl fill
cl fill
brown mott
cl brown-gray mot lam
cl gray lam
24
48 Inch Storm Sewer
flow
flow
gray mott
48 Inch Storm Sewer Invert 570 ft (flow in)
cl gray mott
cl gray mott
sc till
sm till
000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
Horizontal Distance (Feet)

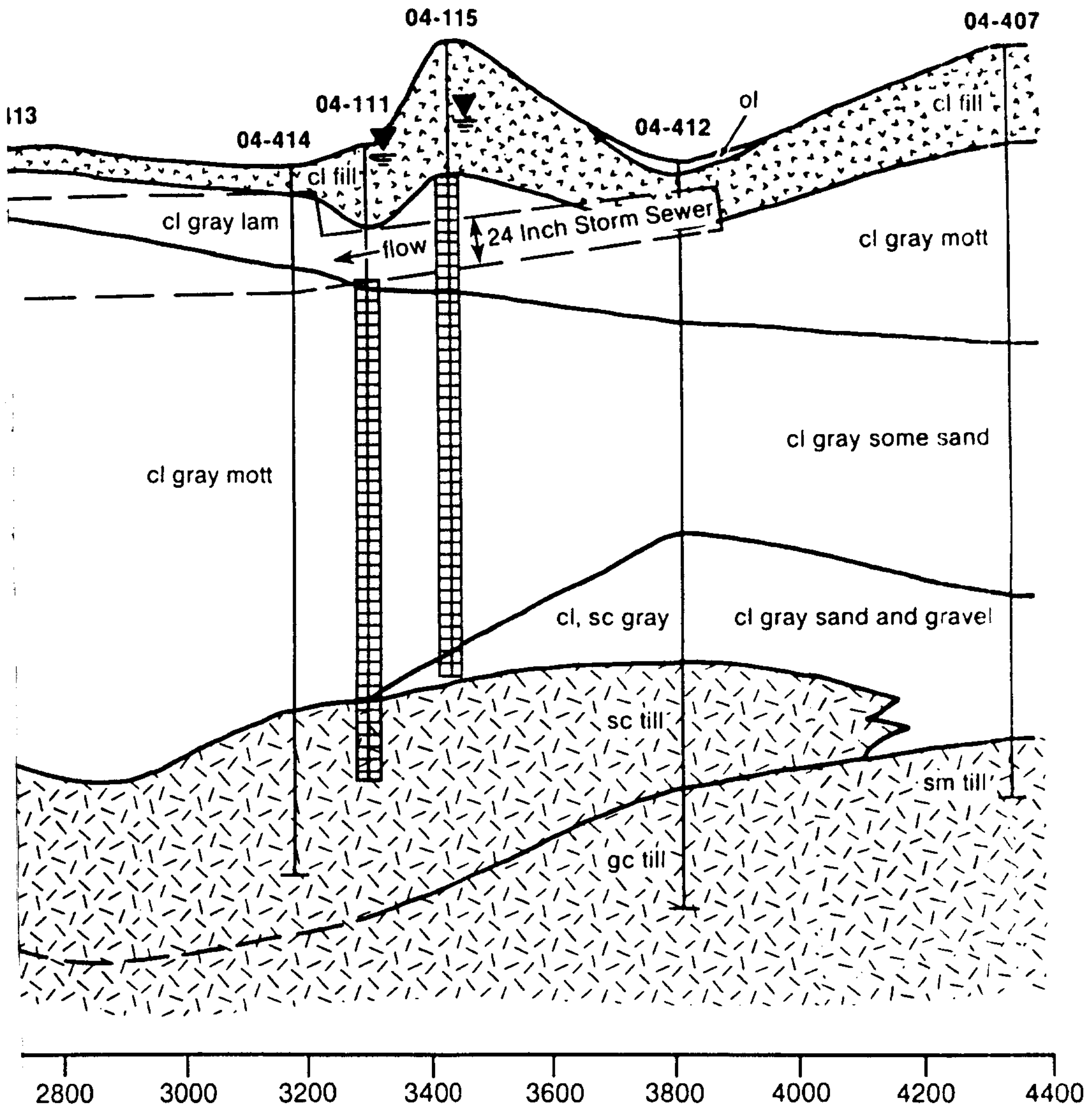
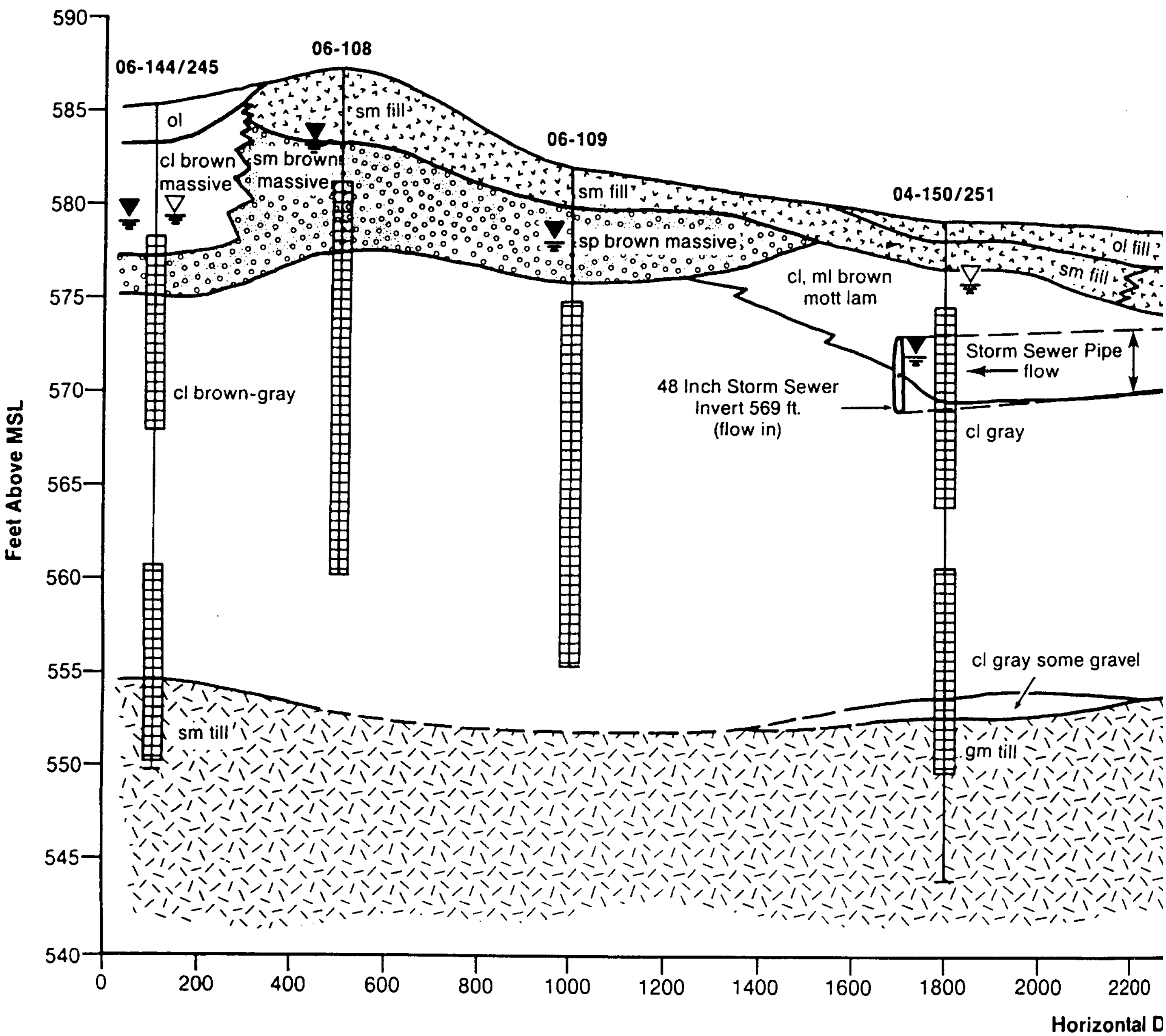


FIGURE 4-58 WRMP/NWLF GEOLOGIC CROSS SECTION A-A'

North B



590
585
580
575
570
565
560
555
550
545
540
Feet Above MSL
06-144/245
06-108
06-109
04-150/251
ol
sm fill
cl brown massive
sm brown massive
sm fill
sp brown massive
cl, ml brown mott lam
ol fill
sm fill
cl brown-gray
Storm Sewer Pipe
flow
48 Inch Storm Sewer Invert 569 ft. (flow in)
cl gray
cl gray some gravel
sm till
gm till
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
Horizontal D

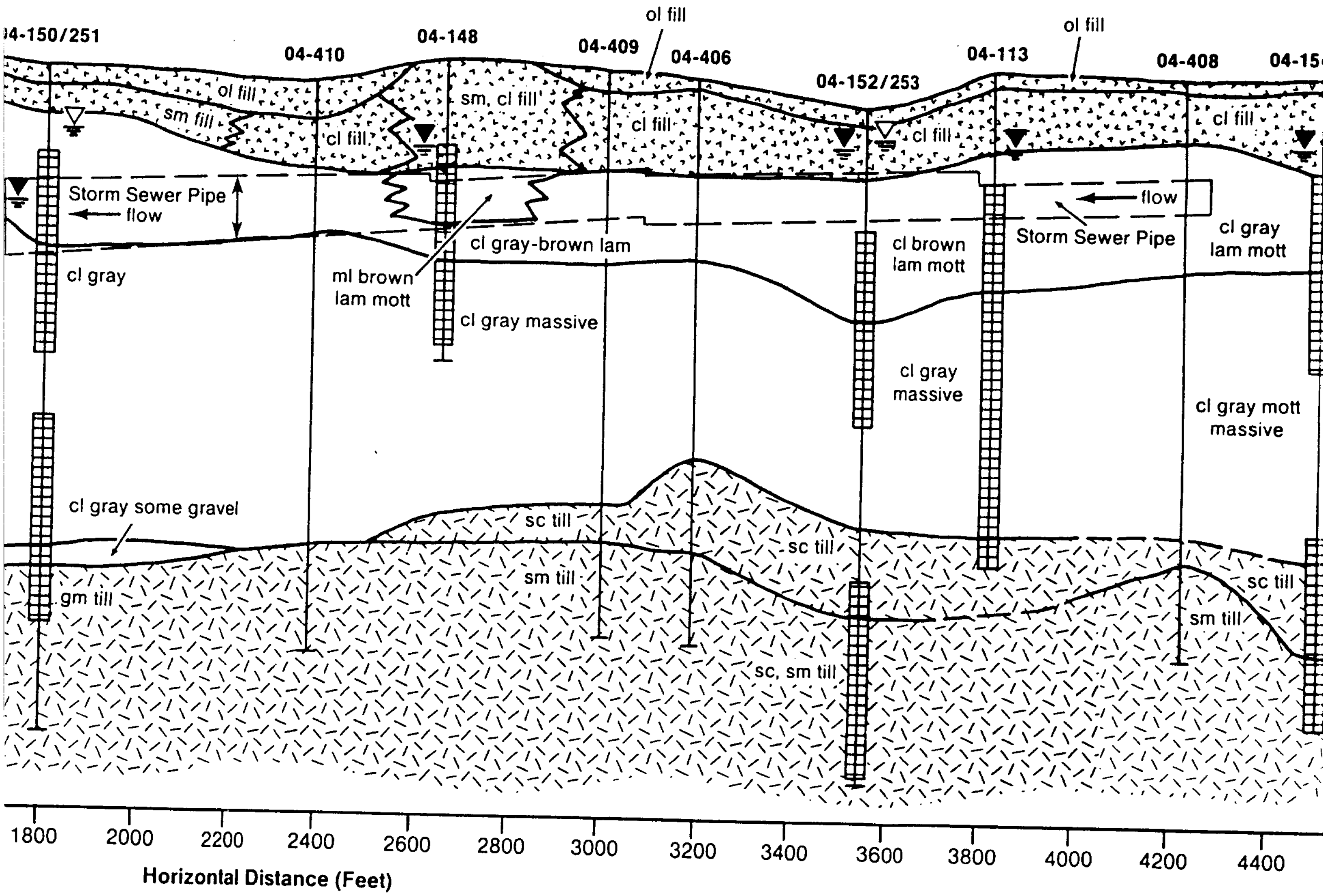


FIGURE 4-59 WRMP/NWL
CROSS SEC

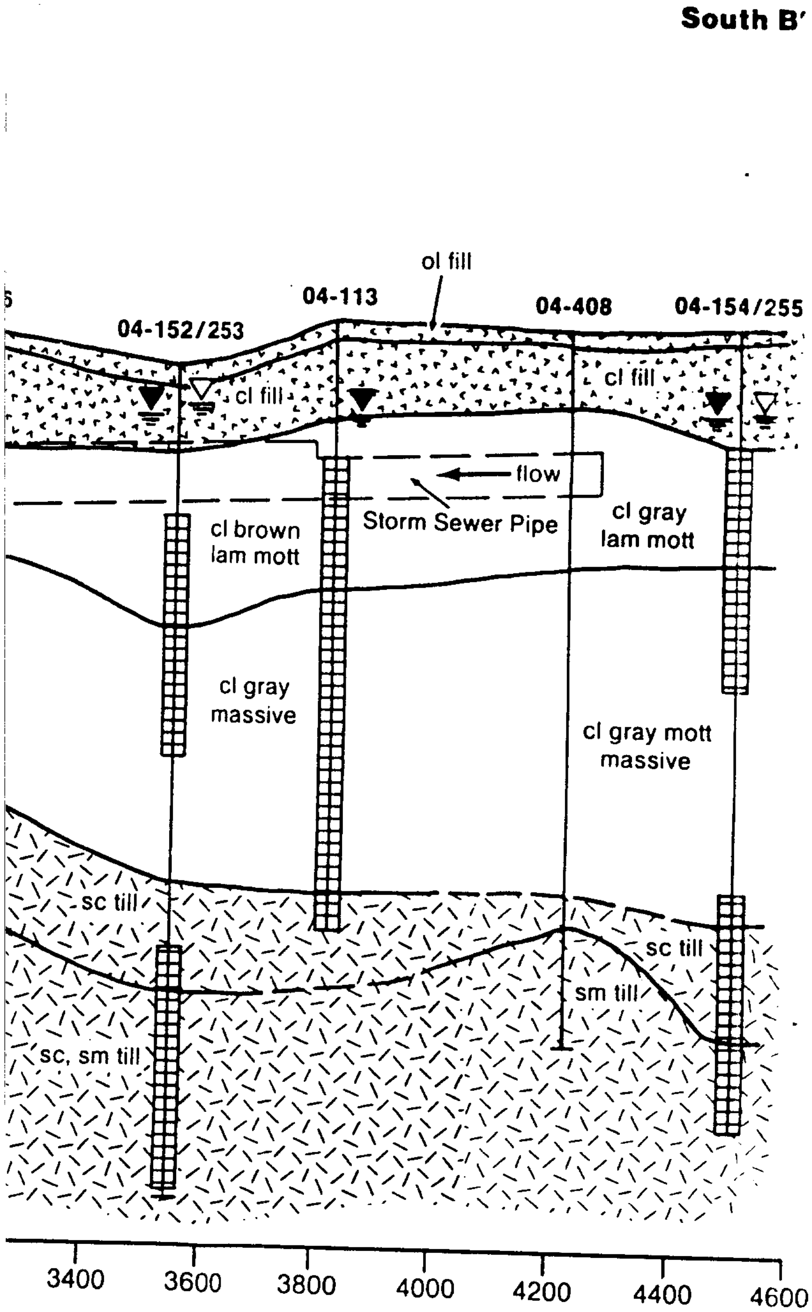


FIGURE 4-59 WRMP/NWLF GEOLOGIC CROSS SECTION B-B′

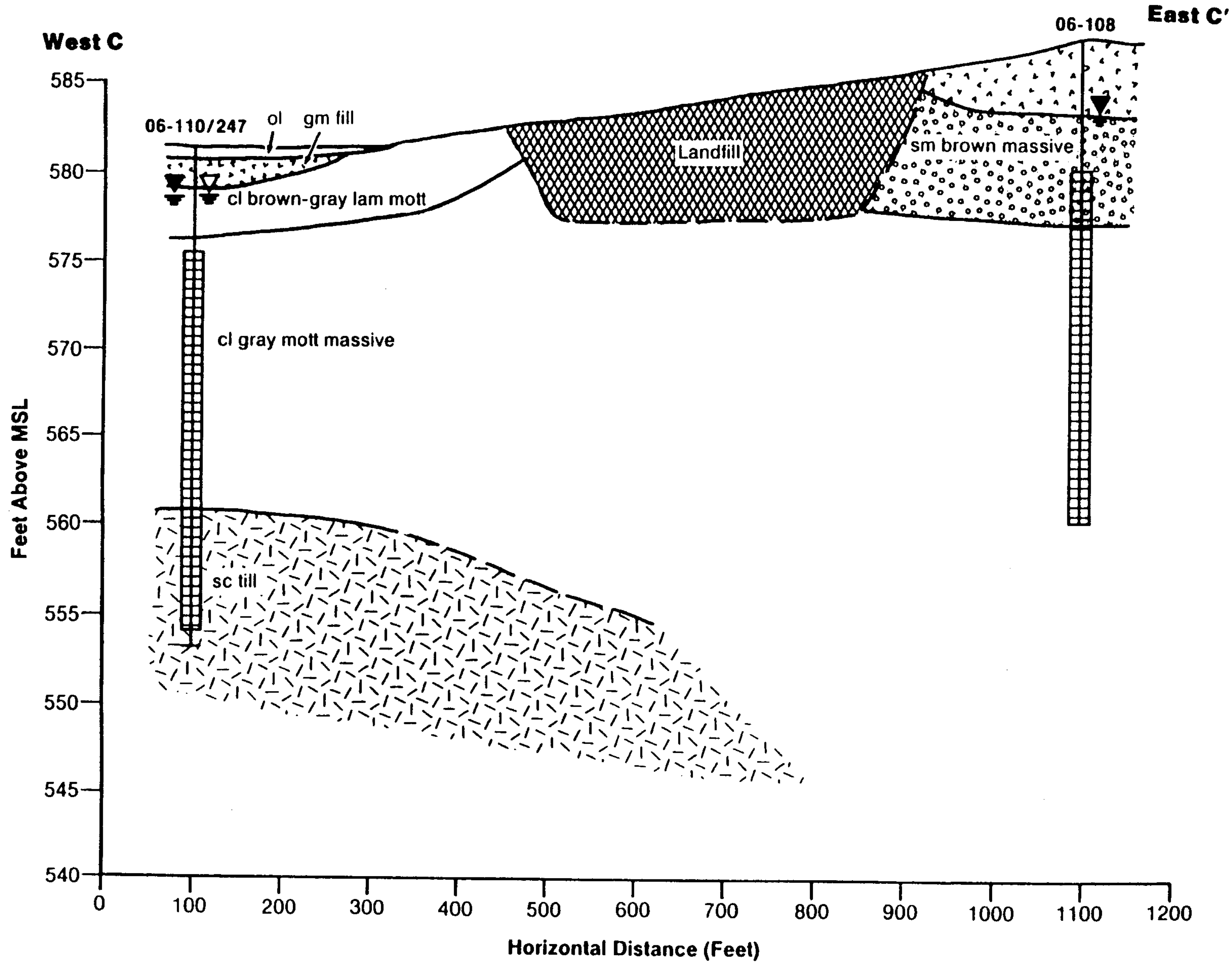
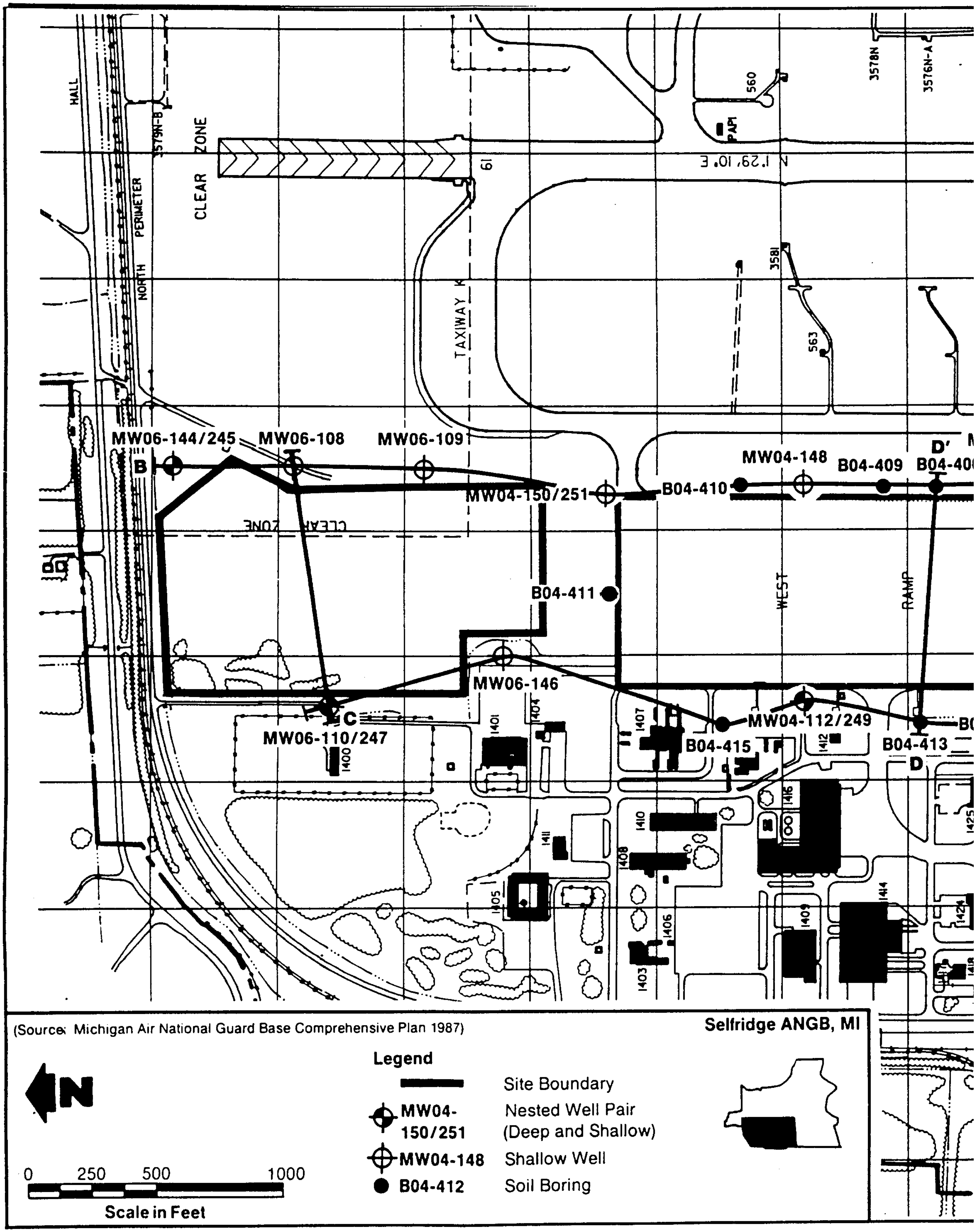
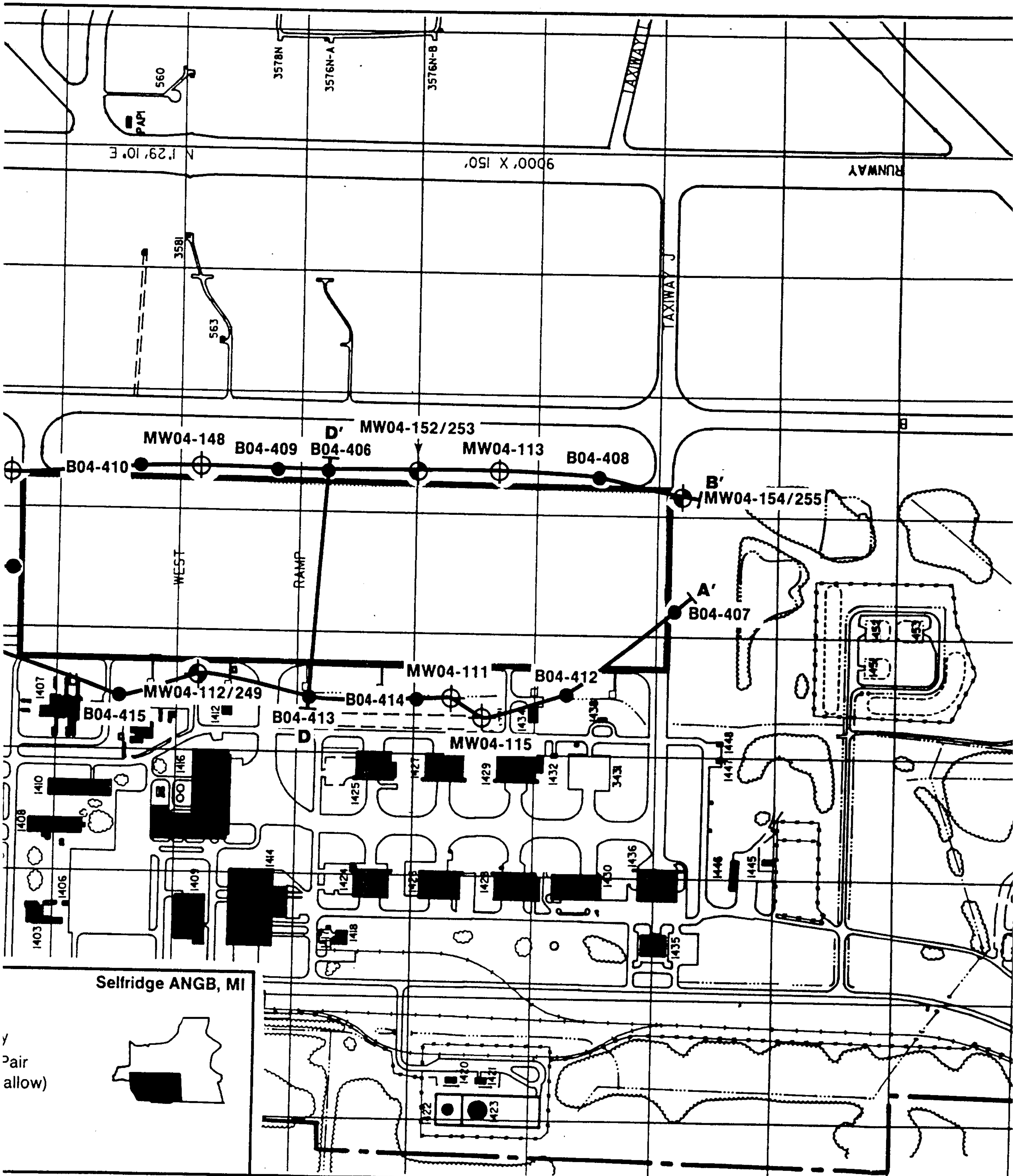


FIGURE 4-60 WRMP/NWLF GEOLOGIC CROSS SECTION C-C'



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
0
250
500
1000
Scale in Feet
Legend
Site Boundary
MW04-150/251
Nested Well Pair (Deep and Shallow)
MW04-148
Shallow Well
B04-412
Soil Boring
HALL
NORTH
PERIMETER
3579N-B
CLEAR ZONE
TAXIWAY K
WEST
RAMP
560
PAPI
3578N
3576N-A
N 1,29',10' E
3581
563
MW06-144/245
MW06-108
MW06-109
MW04-150/251
B04-410
MW04-148
B04-409
B04-406
B04-411
MW06-146
MW06-110/247
B04-415
MW04-112/249
B04-413
B
C
D
D'
1400
1401
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1414
1416
1418
1424
1425



MW04-148
B04-410
B04-409
D'
B04-406
MW04-152/253
MW04-113
B04-408
B'
MW04-154/255
A'
B04-407
MW04-111
B04-412
MW04-112/249
B04-415
B04-413
D
B04-414
MW04-115
WEST
RAMP
TAXIWAY J
TAXIWAY
9000' X 150'
RUNWAY
N 1°29' 10" E
PAPI
560
3578N
3576N-A
3576N-B
3581
563
Selfridge ANGB, MI
y
Pair
allow)

FIGURE 4

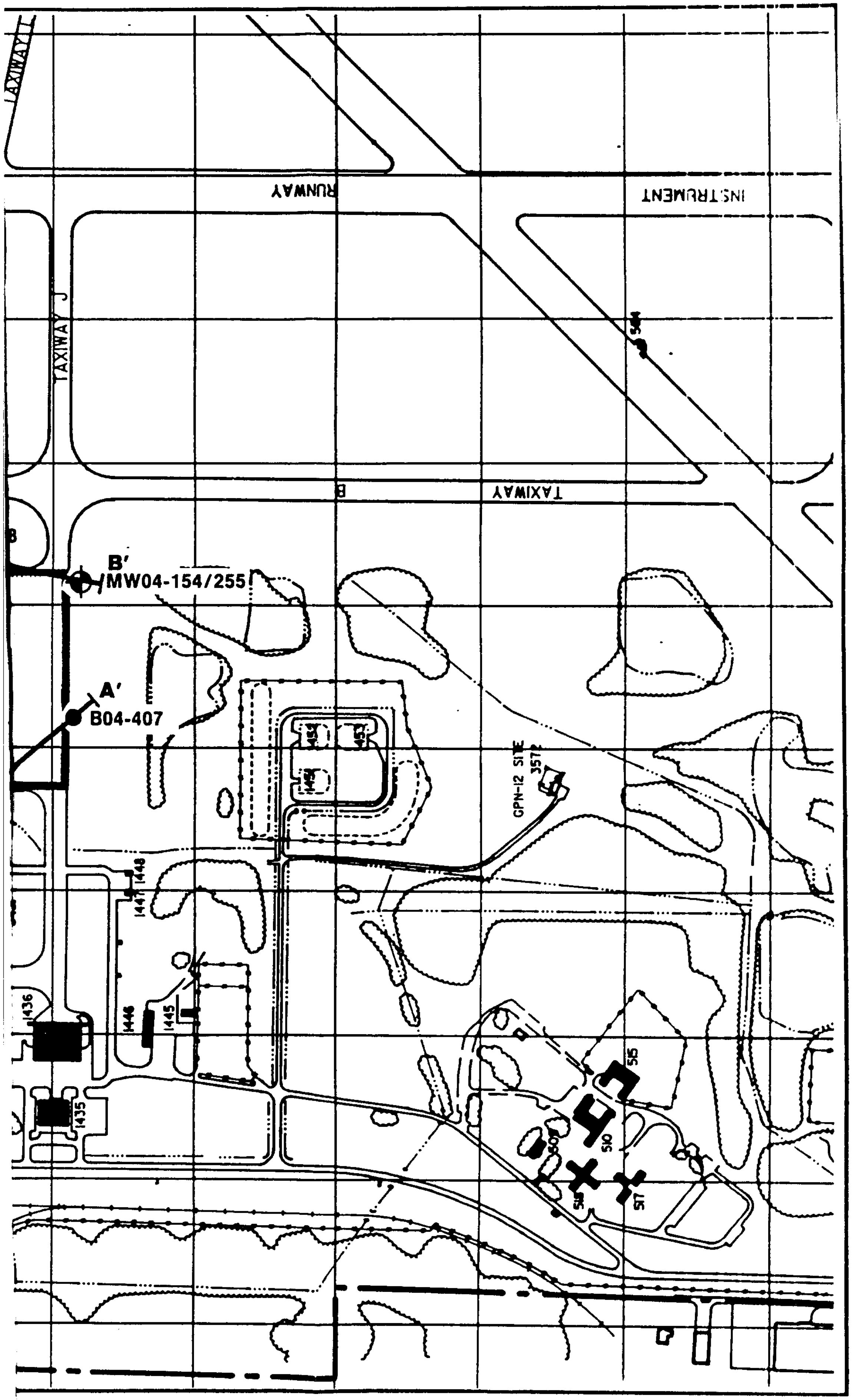


FIGURE 4-61 TRACE OF CROSS SECTIONS A-A', B-B', C-C' AND D-D' AT WRMP/NWLF

OVA readings above the background level of 1 unit generally were not obtained at NWLF for soil samples taken from the groundwater monitor well borings above 10 to 15 feet. Soil samples below these depths at NWLF yielded OVA measurements of 0.5 to 10 units. Visible evidence of soil contamination at the site was limited to a yellowish, oily-looking film that was present on the surface of the soil core from 15 to 20 feet in monitor well boring 06-247. No unusual odors were noted during drilling at NWLF.

Sand from the beach sand deposit was observed in borings for monitor wells along the eastern and southern sides of the NWLF site. A remnant of Sugar Bush Road enters along the northeastern corner of site and follows along the trend of this beach sand deposit. An isopach map of the sand (see Figure 4-6) displays the northeast to southwest trend of the beach sand deposit. The thickest sequence of beach sand (6 feet) was observed at monitor well location 06-108.

Figure 4-59 shows a cross section through the eastern side of NWLF and a portion of WRMP. This profile view shows the relationship of the subsurface geology between the two sites. Fill material is observed covering the top of the two sites. The beach sand deposit thins to the south and was not observed in soil borings or monitor well borings at WRMP.

A portion of the stormwater drainage network is located along the southern edge of the NWLF site. Catch basins for the drainage network are located here as well as to the southeast of the site. Surface water runoff from the southern portion of NWLF is intercepted by these catch basins. There are two surface drainage ditches at NWLF, one on the western border that drains runoff into the second drainage ditch along the northern border of NWLF.

4.9.1.2 Extent and Character of Unsaturated Zone -- NWLF

The unsaturated zone at NWLF extended to a depth of 10 to 12 feet, based upon observations made during drilling of the monitor wells. The upper portion of this zone is comprised of an organic topsoil horizon, silt and sand fill, the beach sand deposit, and the top of the lacustrine clay unit. Soils are drab colored and generally massive. Iron staining and gray mottling were noted in the beach sand and lacustrine clay.

From field observations, the top of the water table was placed as the boundary between unsaturated and saturated soil. Mottling was also used to determine this boundary. Gray mottling was predominant below the unsaturated zone.

4.9.1.3 Groundwater Conditions -- NWLF

The shallow monitor wells installed during the IRP Stage 2 investigation were placed at depths of 16 to 17.5 feet in brown

and gray clay. The shallow borings installed during the Phase II Stage 1 investigation were placed at depths of 25 to 28 feet in brown and gray lacustrine clay and sandy till. The deep monitor wells were installed at depths of 28 to 35 feet in gray lacustrine clay and till.

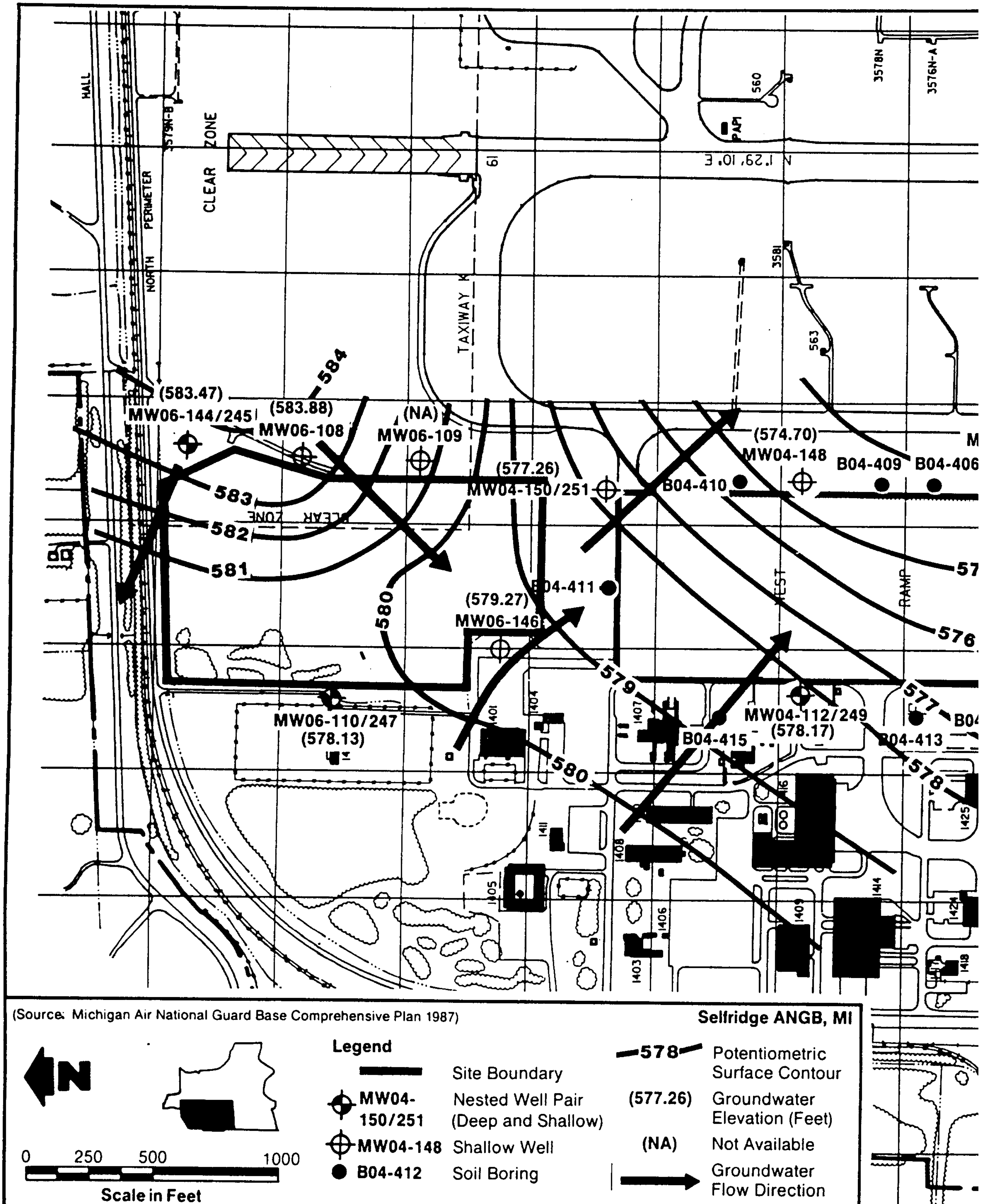
Water level elevations were measured seven different times between 1 February and 1 August 1988. An elevated water level in monitor well 06-109 during March 1988 and freezing weather conditions caused the formation of ice within the well and no water level measurements could be taken.

All monitor wells, with one exception, had groundwater level elevations above the surface elevation of Lake St. Clair during each of the measurement periods. The exception was 1 February 1988. During this time the water level elevation in monitor well 06-110 was 0.55 feet lower than the surface of Lake St. Clair. The water levels in the monitor wells on average were from 3.10 to 8.48 feet higher than the surface of Lake St. Clair. The highest water level was consistently measured in monitor well 06-108 for each of the seven measurement periods.

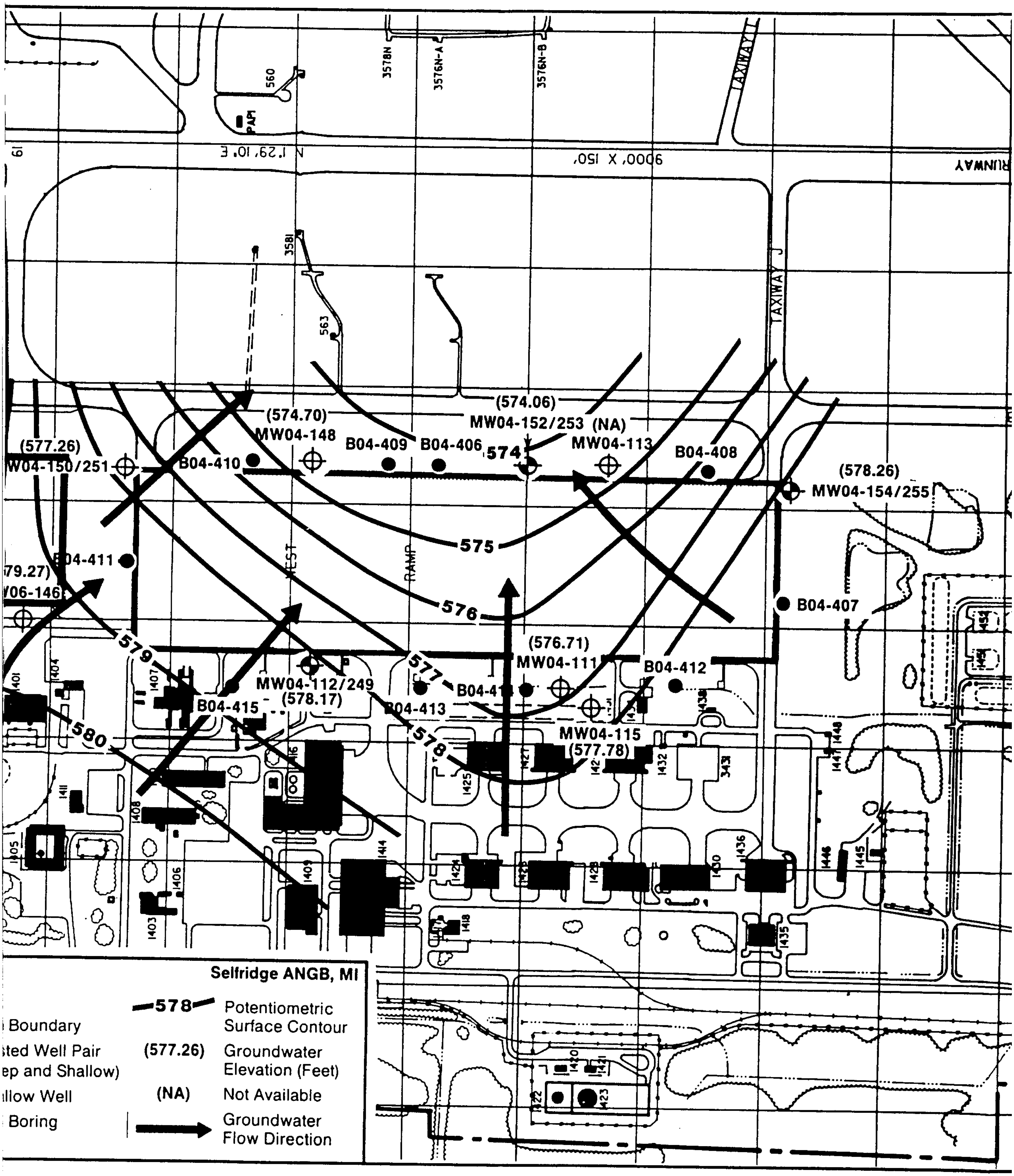
Potentiometric surface maps were constructed for both shallow and deep monitor wells at NWLF. The group of shallow wells includes monitor wells 06-108, 06-109, 06-110, 06-144, and 06-146. Monitor wells 06-245 and 06-247 are classified as deep wells because the screens are set at 25 to 35 feet BLS. Data from the monitor wells at the northern end of WRMP were also used to construct the water table maps for NWLF.

Figure 4-62 shows the potentiometric surface map based upon shallow monitor well data for 21 March 1988. A groundwater high exists in the northeastern corner of the site. Based upon this map, groundwater flow at NWLF is toward the northwest and southwest, away from the groundwater high. Along the southern end of the site groundwater flow direction is toward the south. This change in flow direction can be attributed in part to interception of groundwater by the stormwater drainage system located between the NWLF site and the WRMP site. This effect can also be seen in the potentiometric map for the WRMP area, as shown in Figure 4-62 and discussed in the section on WRMP.

The shallow monitor well potentiometric surface map for 1 August 1988 (see Figure 4-63) shows a groundwater high located in the area around monitor well 06-108. Groundwater flow at NWLF occurs radially away from this location. The occurrence of this apparent groundwater high is due to monitor well 06-108 being screened in the beach sand deposit. Perched water conditions within the sand deposit caused by the less permeable clay below create the elevated water levels observed in the monitor well. On 1 August 1988 groundwater flow was to the north, away from the groundwater high, and to the south, with some deflection



HALL
NORTH PERIMETER
CLEAR ZONE
TAXIWAY K
PAPI
560
563
3581
3578N
3576N-A
(583.47)
MW06-144/245
(583.88)
MW06-108
(NA)
MW06-109
584
583
582
581
580
(577.26)
MW04-150/251
B04-410
(574.70)
MW04-148
B04-409
B04-406
B04-411
(579.27)
MW06-146
579
576
577
578
MW06-110/247
(578.13)
MW04-112/249
(578.17)
B04-415
B04-413
WEST
RAMP
1401
1404
1405
1406
1407
1408
1409
1411
1403
1414
1416
1418
1424
1425
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
N
Legend
Site Boundary
MW04-150/251 Nested Well Pair (Deep and Shallow)
MW04-148 Shallow Well
B04-412 Soil Boring
578 Potentiometric Surface Contour
(577.26) Groundwater Elevation (Feet)
(NA) Not Available
Groundwater Flow Direction
0 250 500 1000
Scale in Feet



Selfridge ANGB, MI
Boundary
sted Well Pair
ep and Shallow)
llow Well
Boring
578 Potentiometric Surface Contour
(577.26) Groundwater Elevation (Feet)
(NA) Not Available
Groundwater Flow Direction
TAXIWAY J
9000' X 150'
RUNWAY
N 1°29' 10" E
WEST RAMP
(574.70) MW04-148
(574.06) MW04-152/253 (NA)
(577.26) W04-150/251
(578.26) MW04-154/255
MW04-113
B04-409
B04-406
B04-410
B04-408
B04-411
B04-407
B04-412
B04-413
B04-415
(576.71) MW04-111
MW04-112/249 (578.17)
MW04-115 (577.78)
79.27)
W06-146
574
575
576
577
578
579
580

FIGURE

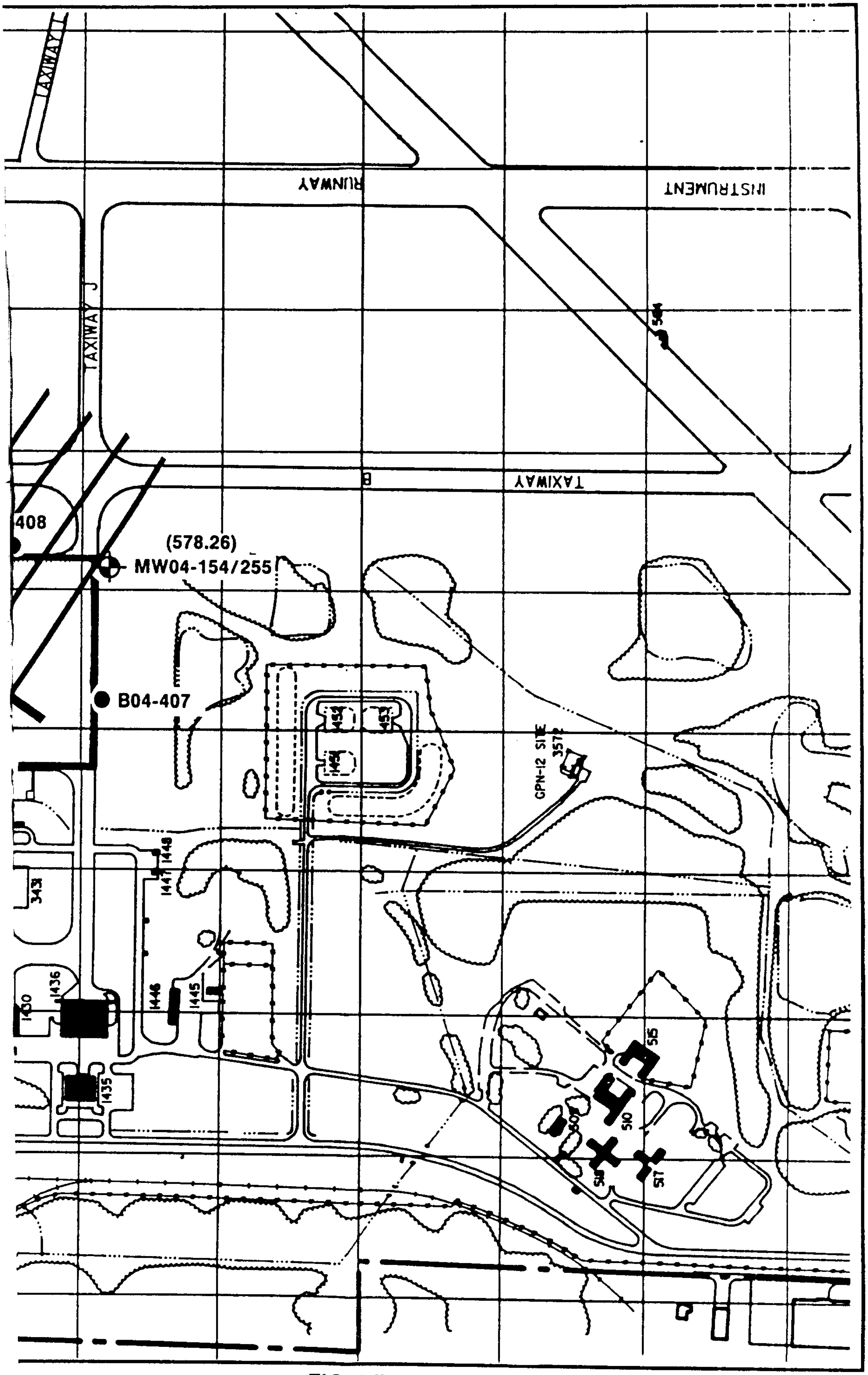
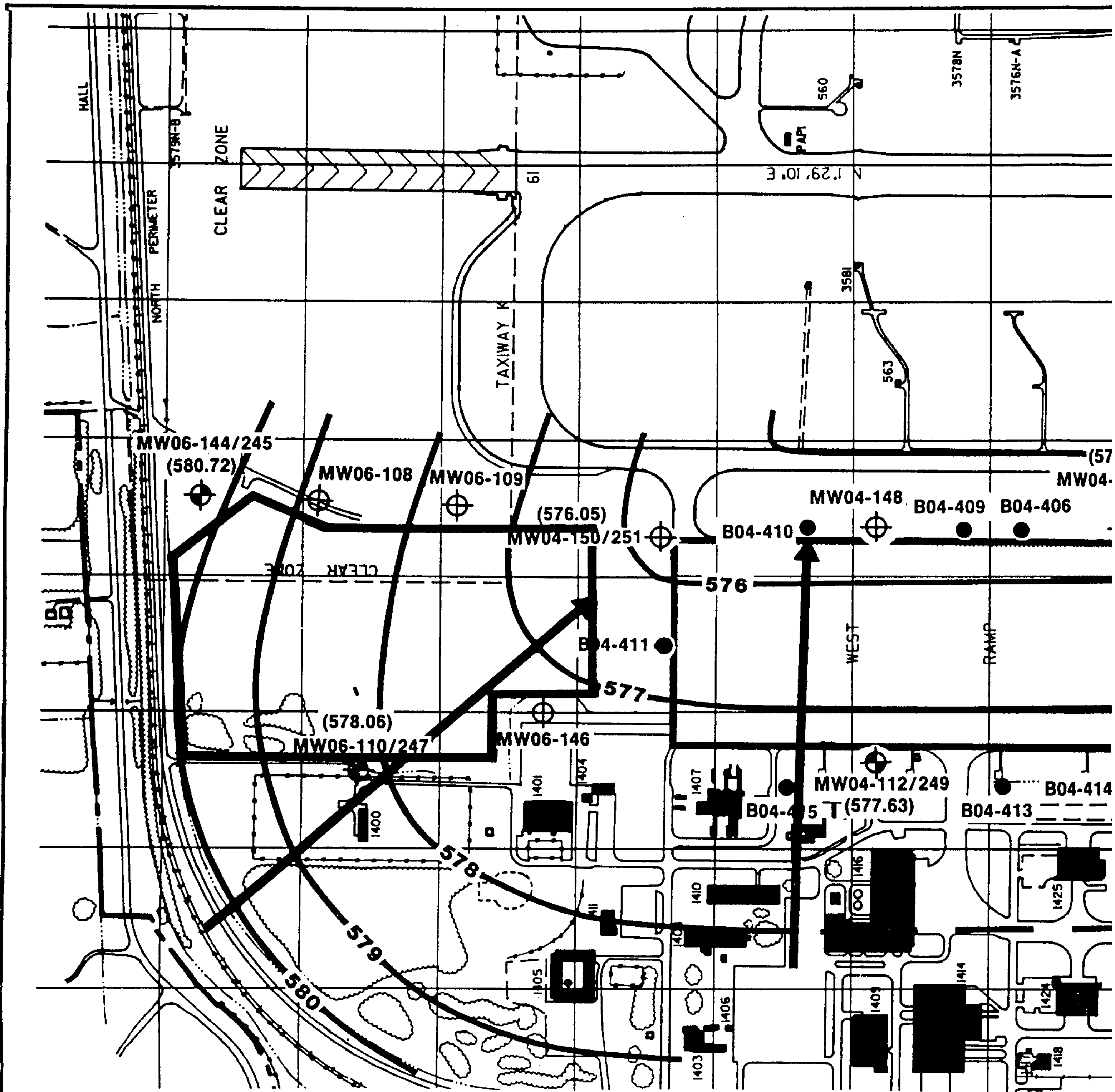


FIGURE 4-62 WRMP/NWLF POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 21 MARCH 1988



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

Site Boundary	
MW04-150/251	Nested Well Pair (Deep and Shallow)
MW04-148	Shallow Well
B04-412	Soil Boring
577	Potentiometric Surface Contour
(575.70)	Groundwater Elevation (Feet)
	Groundwater Flow Direction

N

0 250 500 1000

Scale in Feet

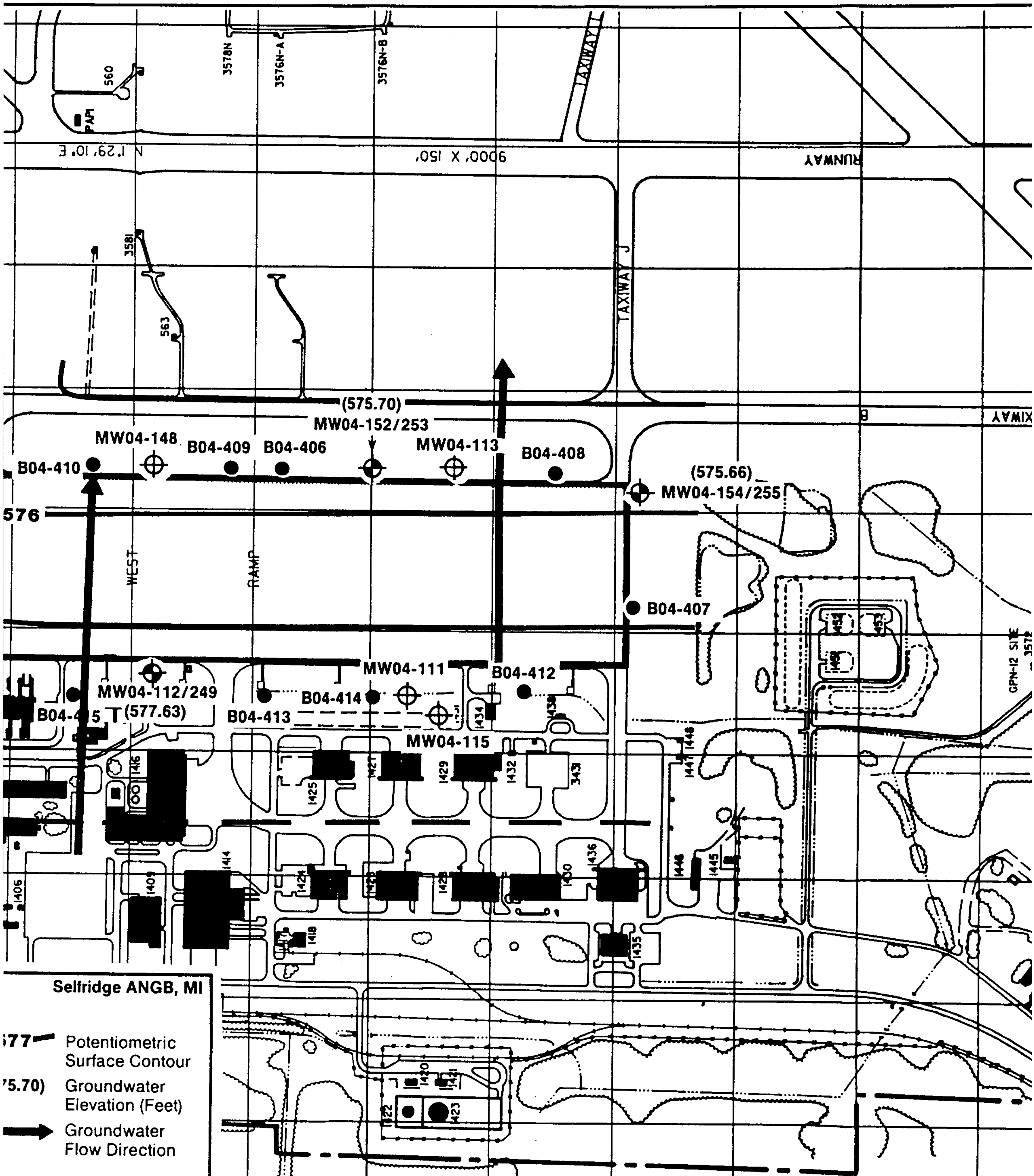


FIGURE 4-63 WRM POT MAP ON 2

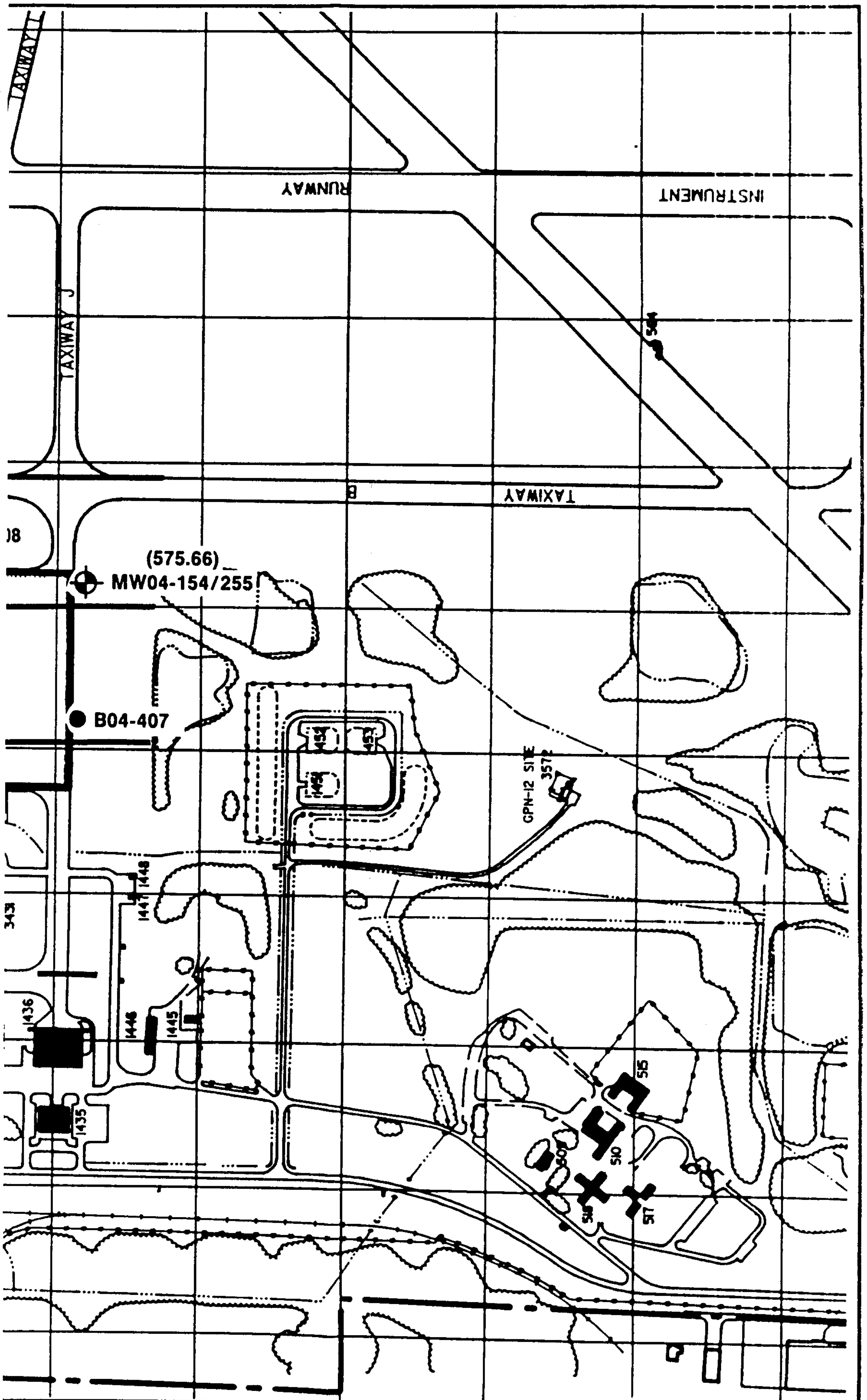


FIGURE 4-63 WRMP/NWLF
POTENTIOMETRIC SURFACE
MAP FOR DEEP MONITOR WELLS
ON 21 MARCH 1988

toward the WRMP, as seen in Figure 4-63. Groundwater on the western side of NWLF moves in a southeasterly direction. Figure 4-64 shows the deep monitor well potentiometric surface map for 21 March 1988. Groundwater flow from NWLF during this period is toward the south and southeast. The deep monitor well potentiometric surface map for 1 August 1988 is presented in Figure 4-65. Groundwater flow was to the south and southeast from NWLF toward WRMP. No major changes in flow direction appear when comparing these two maps.

Based upon the 21 March 1988 shallow monitor well potentiometric surface map, the hydraulic gradient is 0.005 ft/ft. The hydraulic gradient for the 1 August 1988 shallow monitor well potentiometric surface map was 0.01 ft/ft. The hydraulic gradient for the deep monitor well potentiometric surface map for 21 March 1988 was approximately 0.003 ft/ft and for 1 August 1988 it was 0.002 ft/ft.

The hydraulic conductivity (K) values determined for each monitor well at NWLF are presented in Table 3-18. The average hydraulic conductivity value with respect to both shallow and deep monitor wells is 3.34×10^{-6} ft/sec (1.02×10^{-4} cm/sec). The K value calculated for all shallow monitor wells (06-108, 06-109, 06-110, 06-144, and 06-146) at NWLF is 3.41×10^{-6} ft/sec (1.04×10^{-4} cm/sec). For the deep monitor wells (06-247 and 06-245) at NWLF the average K value is 3.17×10^{-6} ft/sec (9.67×10^{-5} cm/sec).

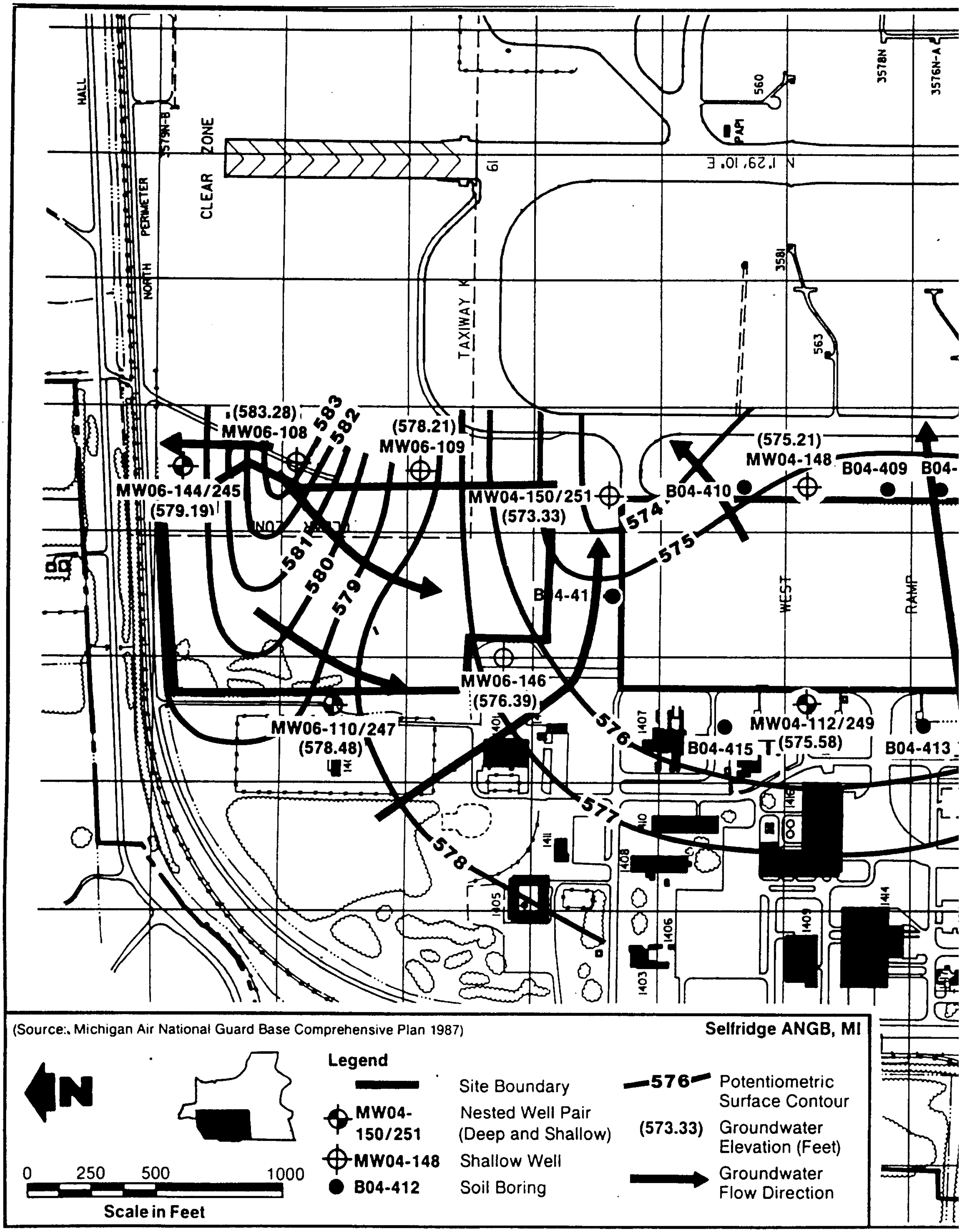
The groundwater velocity (V) can be calculated for NWLF based upon the average hydraulic conductivity value (K), the gradient (i), and the effective porosity (n) of the upper and lower clay units using the equation $V = Ki/n$. The gradients used were those calculated from the potentiometric surface maps.

Using the calculated average K value of 3.41×10^{-6} ft/sec for shallow monitor wells on 21 March 1988 and an effective porosity value of 0.15, a shallow monitor well groundwater velocity was calculated for 21 March 1988 as 1.14×10^{-7} ft/sec (3.60 ft/year).

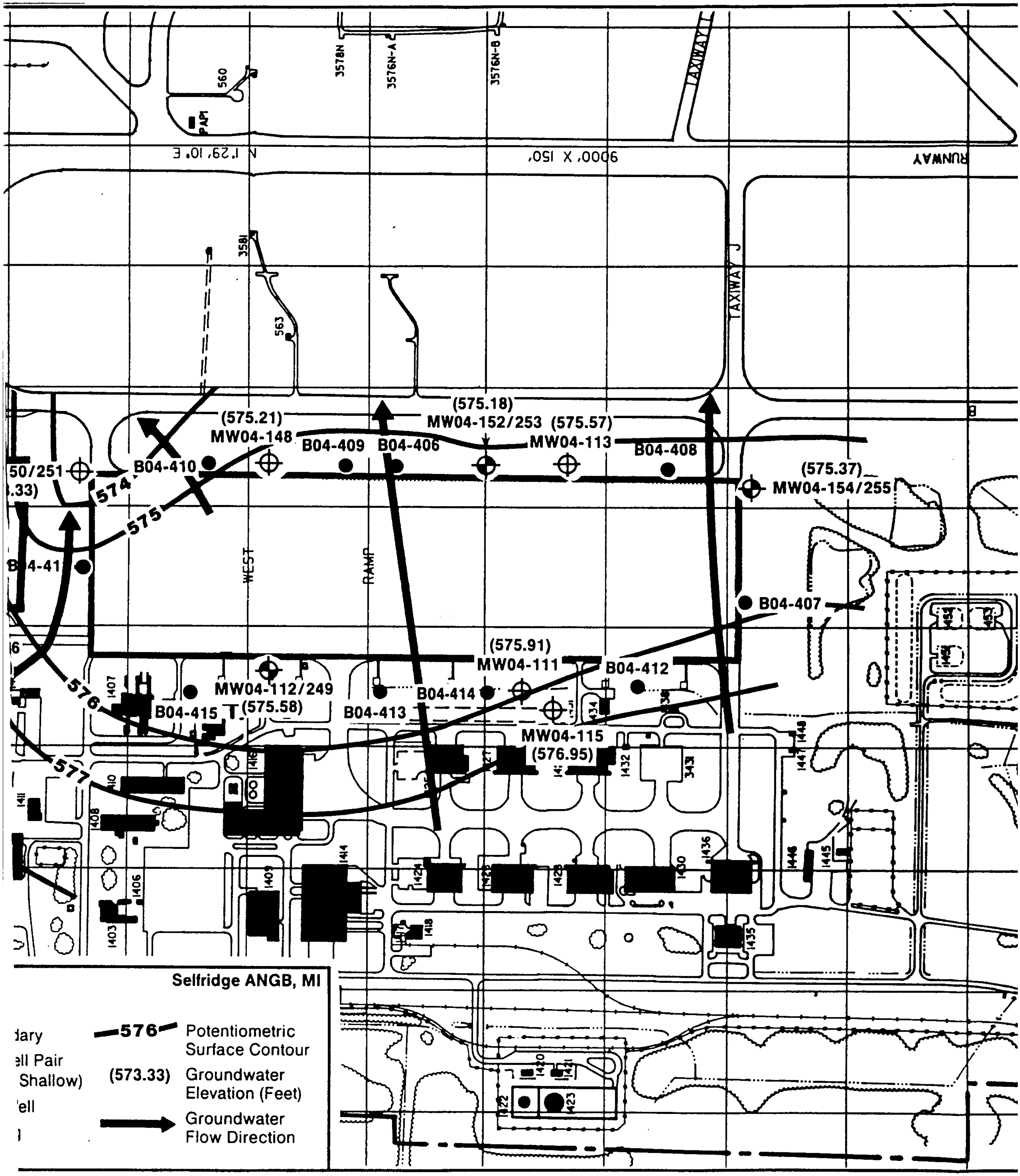
Using the shallow monitor well average hydraulic conductivity of 3.41×10^{-6} ft/sec and an effective porosity of 0.15, a shallow groundwater velocity was calculated for 1 August 1988 to be 2.27×10^{-7} ft/sec (7.16 ft/year).

The deep monitor well groundwater velocity for 21 March 1988, calculated from the average deep monitor well K value of 3.17×10^{-6} ft/sec and an effective porosity of 0.15, was 6.34×10^{-8} ft/sec (2.00 ft/year).

Using an effective porosity of 0.15, the calculated deep groundwater velocity for 1 August 1988 was 4.23×10^{-8} ft/sec (1.33 ft/year).



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
CLEAR ZONE
NORTH PERIMETER
HALL
TAXIWAY K
WEST RAMP
MW06-108 (583.28)
MW06-109 (578.21)
MW06-144/245 (579.19)
MW04-150/251 (573.33)
MW04-148 (575.21)
B04-409
B04-410
B04-411
MW06-146 (576.39)
MW06-110/247 (578.48)
MW04-112/249 (575.58)
B04-415
B04-413
583
582
581
580
579
578
577
576
575
574
Legend
Site Boundary
MW04-150/251 Nested Well Pair (Deep and Shallow)
MW04-148 Shallow Well
B04-412 Soil Boring
576 Potentiometric Surface Contour
(573.33) Groundwater Elevation (Feet)
Groundwater Flow Direction
N
0 250 500 1000
Scale in Feet



RUNWAY
9000' X 150'
N 1°29'10" E
TAXIWAY J
WEST
RAMP
560
563
3581
3578N
3576N-A
3576N-B
PAPI
(575.21)
MW04-148
(575.18)
MW04-152/253
(575.57)
MW04-113
B04-409
B04-406
B04-408
B04-410
50/251
.33)
(575.37)
MW04-154/255
B04-407
(575.91)
MW04-111
B04-412
MW04-112/249
(575.58)
B04-414
B04-413
B04-415
MW04-115
(576.95)
574
575
576
577
1407
1410
1411
1408
1406
1403
1409
1414
1416
1418
1424
1426
1428
1430
1432
1434
1435
1436
1445
1446
1447
1448
3431
1420
1421
1422
1423
1453
1454
1455
Selfridge ANGB, MI
dary
ell Pair
Shallow)
'ell
576
Potentiometric Surface Contour
(573.33)
Groundwater Elevation (Feet)
Groundwater Flow Direction

FIGURE 4-6

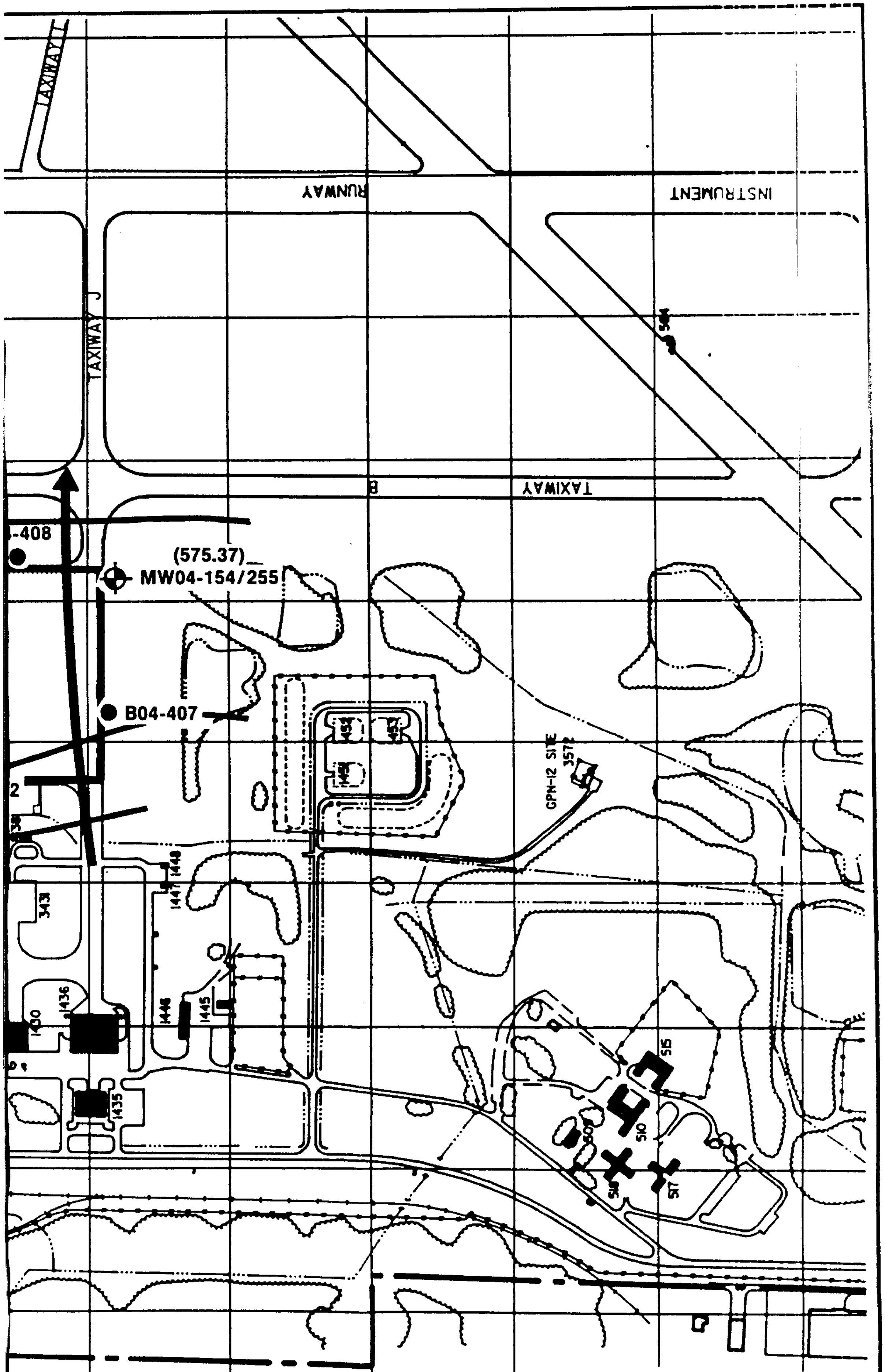
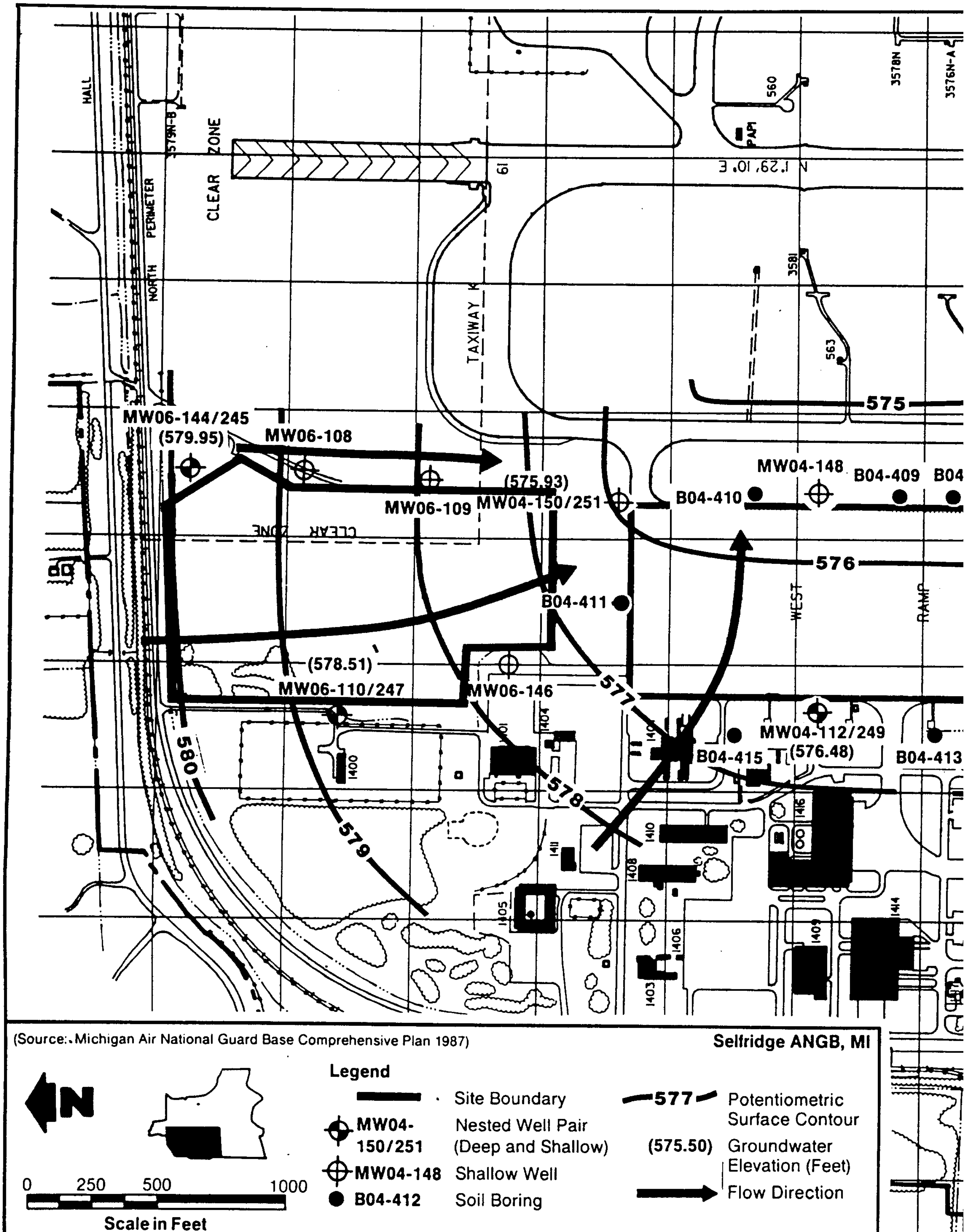
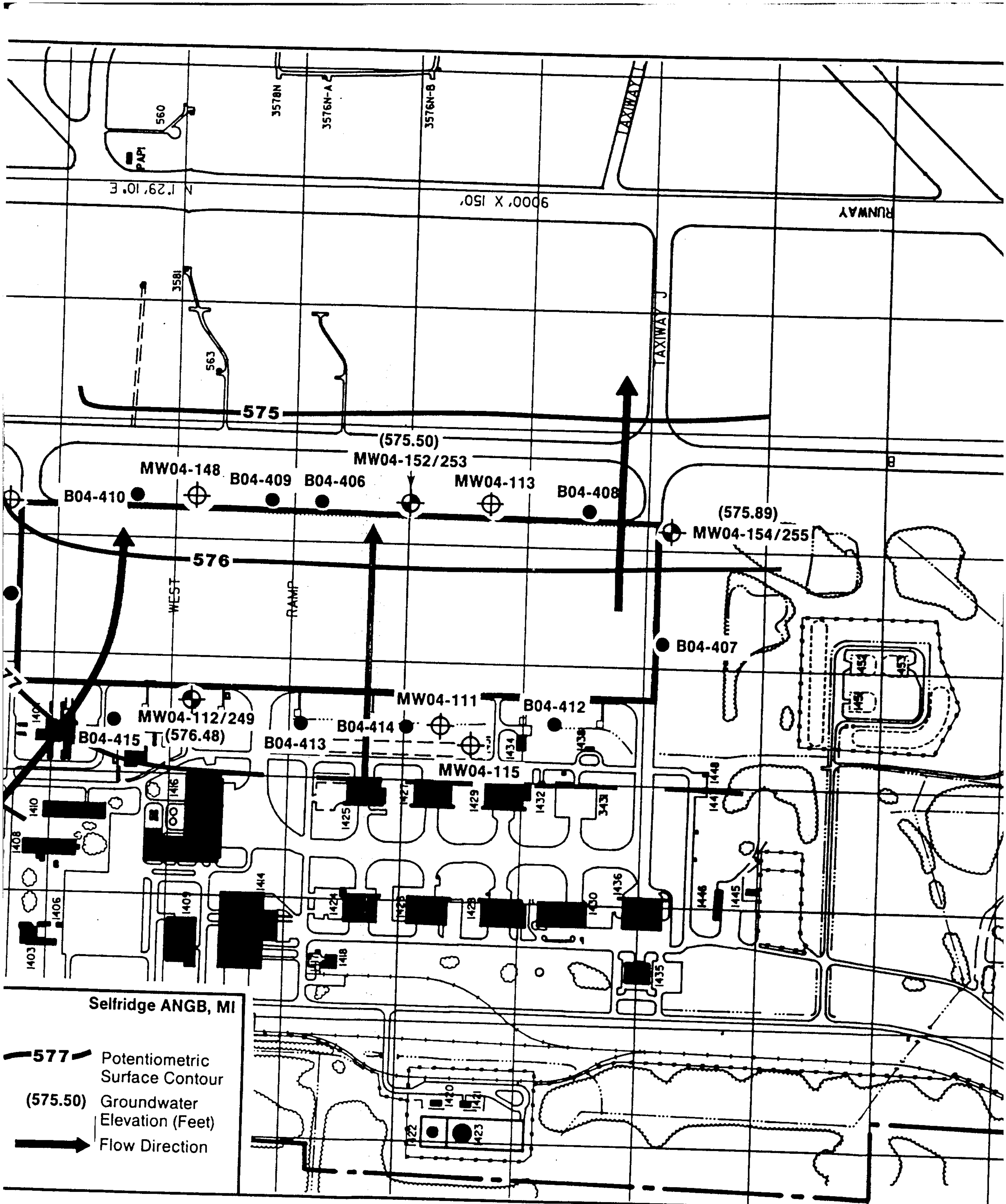


FIGURE 4-64 WRMP/NWLF POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 1 AUGUST 1988



HALL
NORTH PERIMETER
CLEAR ZONE
TAXIWAY K
N 1.29.10 E
PAPI
575
576
577
578
579
580
MW06-144/245
(579.95)
MW06-108
MW06-109
(575.93)
MW04-150/251
B04-410
MW04-148
B04-409
B04-411
(578.51)
MW06-110/247
MW06-146
B04-415
MW04-112/249
(576.48)
B04-413
WEST
RAMP
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW04-150/251 Nested Well Pair (Deep and Shallow)
MW04-148 Shallow Well
B04-412 Soil Boring
577 Potentiometric Surface Contour
(575.50) Groundwater Elevation (Feet)
Flow Direction
N
0 250 500 1000
Scale in Feet



575
576
577
(575.50)
MW04-152/253
MW04-148
B04-409
B04-406
MW04-113
B04-408
B04-410
(575.89)
MW04-154/255
B04-407
MW04-111
B04-412
MW04-112/249
(576.48)
B04-415
B04-414
B04-413
MW04-115
WEST
RAMP
TAXIWAY J
TAXIWAY
RUNWAY
9000' X 150'
Selfridge ANGB, MI
577 Potentiometric Surface Contour
(575.50) Groundwater Elevation (Feet)
Flow Direction

FIGURE 4-65

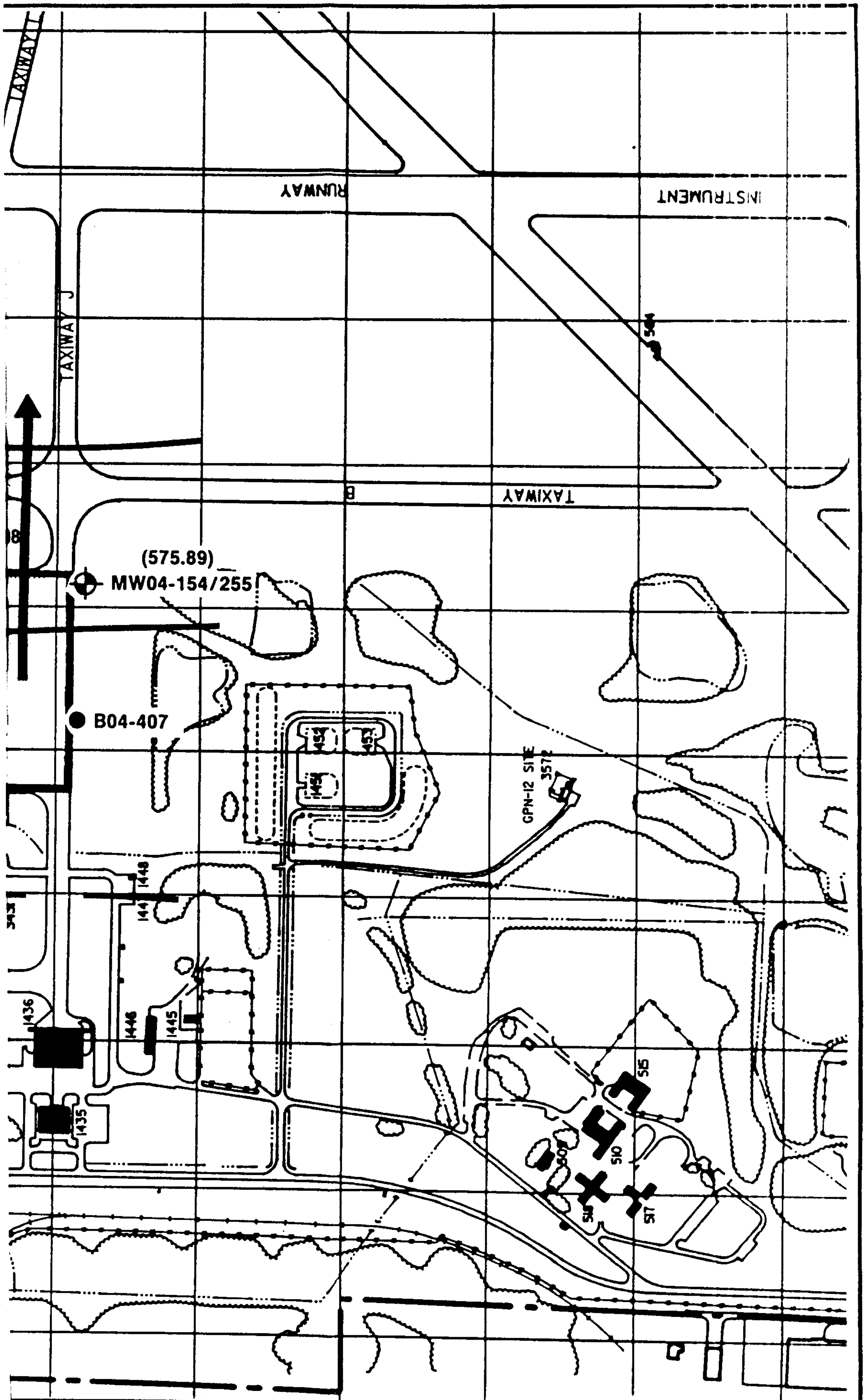


FIGURE 4-65 WRMP/NWLF
POTENTIOMETRIC SURFACE
MAP FOR DEEP MONITOR WELLS
ON 1 AUGUST 1988

Vertical gradients were calculated from two monitor well nests at NWLF using the equation:

$$\text{Vertical gradient} = \frac{DH}{D}$$

where,

DH = The difference in hydraulic head between the two wells.

D = The distance between the two screen centers.

Well nest 06-110/247 had an upward gradient of 0.005 ft/ft, while well nest 06-144/245 had an upward gradient of 0.04 ft/ft. This matches the general pattern of upward gradients seen throughout the base, indicating movement of groundwater slightly upward for this area.

4.9.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- NWLF

The surface of NWLF is covered by natural soils and fill material added to the site after completion of landfilling operations. Additional fill material ("clean" soil from a nearby construction site) was recently placed over the center of the site as was observed during the IRP Stage 2 study. The surface of the site is gently sloping. No landfill material was observed penetrating the surface of the site.

No engineering measures are provided to prevent or control surface water runoff from the NWLF. Surface water drainage either follows the present contour of the land surface toward the sides of the site or ponds in shallow depressions on the surface of the site. One seep is observed on the southeastern portion of NWLF which drains to the stormwater drainage network. Drainage ditches along the sides of the NWLF serve to collect and channel the runoff. Runoff from the northern and northwestern portions of the site collects and flows in a drainage ditch along Perimeter Road. The runoff from the remainder of the site is channeled toward the stormwater catch basins along the southern and southeastern sides of NWLF. Runoff intercepted at these catch basins as well as any groundwater that infiltrates into the drainage system flows to the east through the stormwater drainage network and is discharged by the pump station into Lake St. Clair. Surface water originating from the site may affect the quality of surface water around the site and Lake St. Clair.

4.9.1.5 Direct Contact with Contaminated Media -- NWLF

Access to NWLF is not restricted by any physical means such as a fence around the site. Base maintenance personnel routinely

control vegetation growth on the site and are most likely to come in direct contact with contaminated soil or surface water, if present. Activities involving the repair or installation of utilities could expose workers to contaminants at the site. Other base personnel and visitors accessing the site could potentially come in direct contact with contaminants.

4.9.1.6 Summary of Migration Pathways -- NWLF

Any contaminated soils on the site may provide a pathway of exposure. Maintenance activity and trenching operations for repair or installation of utilities could result in workers coming in contact with contaminants in soils, surface water, or groundwater from NWLF.

Runoff from the site also serves as a pathway for the removal and transport of contaminants. Contaminated surface water can either drain into and flow along the ditch next to Perimeter Road or be intercepted by the stormwater drainage network. By either means the area potentially affected by contaminants from NWLF is increased. In the case where runoff water is collected by the stormwater catch basins, any potential contaminated stormwater runoff is discharged into Lake St. Clair.

A groundwater seep exists near monitor well 06-109. During seasonal wet periods and following heavy rain storms this seep was observed to be actively flowing. Saturated soil and ponded water occur in the vicinity of this seep, and any excess water would drain toward a catch basin located on the eastern side of the site. This seep provides a direct pathway for potentially contaminated groundwater to flow from the site and affect surface soils and water.

Groundwater flow at NWLF is generally toward the south. The creation of a gradient and resulting flow to the south can be attributed to the effect of the stormwater drainage network. Groundwater originating from NWLF, in part, appears to be intercepted by the stormwater drainage system and discharged into Lake St. Clair. This could result in the spread of contaminants to a surface water body, thus increasing the chance for direct contact from recreational use of Lake St. Clair.

4.9.2 Contamination Profile -- NWLF

4.9.2.1 Chemical Results for Soil -- NWLF

Investigative soil samples were collected from each of two monitor well borings and were analyzed for chemical contaminants during the IRP Stage 2 investigation. The soil samples were collected at 10 to 15 feet BLS at location 06-245 (06-345-B001) in the northeastern corner of NWLF and at 5 to 10 feet BLS at location 06-247 (06-347-B001) just to the west of the NWLF.

The soil borings were drilled and soils sampled on 1 February and 2 February 1988. The soils were sent to WESTON/Gulf Coast Laboratories and were analyzed for petroleum hydrocarbons, volatile organics, semivolatile organics, soil moisture content, and metals screen including arsenic, mercury, and selenium. No holding times were exceeded for these samples. The surrogate recoveries ranged from 93 to 112 percent, and the matrix spike recoveries ranged from 83 to 154 percent for the volatile organic analyses. Although some surrogate recoveries were low, all quantification limits were within acceptable limits. Matrix spike recoveries for the metals screen ranged from 11.3 (antimony) to 110 percent (cadmium). All quantification limits were within acceptable limits for the metals screen.

Table 4-57 lists the valid analytes and concentrations detected in the soil collected at NWLF. The detection of 2-butanone (0.019 mg/kg) in 06-345-B001 at trace concentration may indicate that it is a laboratory contaminant. No semivolatile organics were detected in either of the soil samples, but petroleum hydrocarbons (96 mg/kg) were detected in soil sample 06-347-B001.

All metals detected were within the naturally occurring observed range of these elements for the eastern conterminous United States (USGS Professional Paper 1270). A few elements were detected above background ranges determined by the statistical study listed in Table 4-20. These included boron (35.8 and 52.9 mg/kg) and chromium (27.5 and 31.1 mg/kg). Although within statistically determined background ranges, the highest concentrations of aluminum (19,700 mg/kg) and potassium (4,790 mg/kg) measured on base were detected at NWLF.

4.9.2.2 Chemical Results for Groundwater -- NWLF

One duplicate and seven investigative groundwater samples were collected at NWLF for analyses of chemical contaminants during the IRP Stage 2 investigation. They were collected from wells placed around the perimeter of NWLF with the intent of detecting potential groundwater contamination from previous landfilling practices. The groundwater samples were collected from 8 April to 11 April 1988.

The groundwater samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, COD, TOC, alkalinity, and TDS. Holding times were exceeded for COD samples collected from monitor wells 06-108, 06-109, 06-110, and 06-247. The wells were resampled for those parameters on 7 August 1988. No holding times were exceeded for the resampled analytes.

Surrogate recoveries for purgeable halocarbons analyses ranged from 55 to 123 percent, and matrix spike recoveries ranged from

TABLE 4-57

VALID ANALYTES DETECTED IN SOIL AT NWLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

ANALYTE	SAMPLE # / RFW # / SAMPLE DATE / DEPTH / % MOISTURE	06-345-B001 / 123089 / 02-FEB-88 / 10-15 FEET / 29.0			06-347-B001 / 123086 / 02-FEB-88 / 5-10 FEET / 25.1		
	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ACETONE	SW5030/SW8240	0.014		ND	0.013		NV
2-BUTANONE	SW5030/SW8240	0.014	0.019	=	0.013		ND
TOLUENE	SW5030/SW8240	0.007		NV	0.007		NV
PETROLEUM HYDROCARBONS	SW3550/E418.1	70.1		ND	66.1	96	=
ALUMINUM, TOTAL	SW3050/SW6010	19.5	18200	=	17.5	19700	=
ARSENIC, TOTAL	SW3050/SW7060	19.3		ND	9.5	12.5	=
BORON, TOTAL	SW3050/SW6010	19.5	35.8	=	17.5	52.9	=
BARIUM, TOTAL	SW3050/SW6010	2.4	120	=	2.2	103	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.19	0.82	=	0.19	0.84	=
CALCIUM, TOTAL	SW3050/SW6010	9.7	41000	=	8.7	37300	=
CADMIUM, TOTAL	SW3050/SW6010	0.97	2	=	0.87	1	=
COBALT	SW3050/SW6010	3.9		NV	3.5		NV
CHROMIUM, TOTAL	SW3050/SW6010	1.9	27.5	=	1.7	31.1	=
COPPER, TOTAL	SW3050/SW6010	2.9	19.1	=	2.6	19.9	=
IRON, TOTAL	SW3050/SW6010	3.9	25300	=	3.5	26300	=
POTASSIUM, TOTAL	SW3050/SW6010	974	4360	=	875	4790	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.5	16200	=	17.5	14400	=
MANGANESE, TOTAL	SW3050/SW6010	0.97	449	=	0.87	476	=
SODIUM, TOTAL	SW3050/SW6010	87.6	306	=	78.7	270	=
NICKEL, TOTAL	SW3050/SW6010	4.9	34.7	=	4.4	41.8	=
SILICON, TOTAL	SW3050/SW6010	19.5	41.3	=	17.5		ND
VANADIUM, TOTAL	SW3050/SW6010	4	33.1	=	3.9	34.7	=
ZINC, TOTAL	SW3050/SW6010	0.97	66.3	=	0.87	65.7	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

80 to 95 percent. Surrogate recoveries for purgeable aromatics analyses ranged from 69 to 86 percent, and matrix spike recoveries ranged from 125 to 129 percent. Semivolatile surrogate recoveries ranged from 21 to 149 percent, and matrix spike recoveries ranged from 41 to 156 percent. Matrix spike recoveries ranged from 73.5 to 119 percent. All surrogate recoveries, matrix spike recoveries, and detection limits were within quality control limits.

Table 4-58 lists the valid analytes and concentrations detected in groundwater samples from NWLF. No purgeable halocarbons, purgeable aromatics, or petroleum hydrocarbons were detected in the groundwater samples from NWLF. Semivolatile compounds butyl benzyl phthalate (<1 ug/L) and bis(2-ethylhexyl) phthalate (<1 to 9 ug/L) occurred in trace concentrations in samples from monitor wells 06-108, 06-109, 06-110, 06-245, 06-146 and 06-247. As these are common plasticizers, when they occur at such low concentrations it is difficult to determine whether they are actually present in NWLF groundwater or have been introduced during sampling, shipping, or analysis.

Barium (0.83 to 0.333 mg/L) was detected within background range in almost every groundwater sample. Arsenic (0.01 mg/L) and nickel (0.016 mg/L) were detected in the sample from monitor well 06-144. Nickel (0.035 mg/L) and copper (0.033 mg/L) were detected in sample 06-146-M001. Arsenic (0.01 mg/L) was detected in 06-247-M001 and nickel (0.019 mg/L) in sample 06-108-M001.

Nitrate/nitrite was detected only in sample 06-146-M001 (0.2 mg/L). Chloride (6.1 to 40.0 mg/L) occurred within background range in all samples. Sulfate (82.6 to 137 mg/L) occurred in background concentrations, except in samples 06-109-M001 (209 mg/L) and 06-108-M001 (432 mg/L). Alkalinity (210 to 630 mg/L), TDS (460 to 1,200 mg/L), and TOC (3.6 to 20 mg/L) occurred in background ranges for all groundwater samples. COD occurred above background range for 06-109-M001 (290 mg/L), 06-110-M001 (540 mg/L), and 06-245-M001 (330 mg/L).

4.9.2.3 Chemical Results for Surface Water -- NWLF

Two surface water stations were established in the stormwater system at NWLF. Station 06-519 was placed at a catch basin along a sewer that drains an area to the southwest of NWLF, and 06-520 was placed in a catch basin along a sewer line that drains the eastern portion of NWLF. Two investigative surface water samples were collected on 20 April 1988 after an extended dry period, and two investigative surface water samples were collected on 10 May 1988 after a significant rain event.

The surface water samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons,

TABLE 4-58

VALID ANALYTES DETECTED IN GROUNDWATER AT NWLF,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE		06-108-M001 / 127804 / 08-APR-88			06-109-M001 / 127805 / 08-APR-88			06-110-M001 / 127806 / 08-APR-88			06-144-M001 / 127861 / 09-APR-88			06-144-M101 / 127862 / 09-APR-88			06-146-M001 / 127954 / 11-APR-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
BUTYL BENZYL PHTHALATE	E625	ug/L	10		ND	10		ND	10		ND	10		ND	10		ND	10	1	<
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10	3	<	10	5	<	10	3	<	10	5	<	10	1	<	10	1	<
DI-N-BUTYL PHTHALATE	E625	ug/L	10	1	<	10	2	<	10		ND	10	2	<	10	3	<	10		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.03		ND	1.01		ND	1.02		ND	1.05		ND	1.03		ND	1.04		ND
ALUMINUM, TOTAL	E200.7	mg/L	.200		ND	.200		ND	.200		ND	.200		ND	.200		ND	.200		ND
ARSENIC, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050	0.01	=	.0050		ND	.0050		ND
BORON, TOTAL	E200.7	mg/L	.100	0.193	=	.100	0.369	=	.100		ND	.100	0.187	=	.100	0.168	=	.100	0.145	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.101	=	.0500	0.132	=	.0500	0.83	=	.0500	0.332	=	.0500	0.333	=	.0500	0.151	=
CALCIUM, TOTAL	E200.7	mg/L	.200	266	=	.200	123	=	.200	133	=	.200	101	=	.200	100	=	.200	92.1	=
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND	.0250		ND	.0250		ND	.0250		ND	.0250	0.033	=
IRON, TOTAL	E200.7	mg/L	.0400	0.184	=	.0400	0.069	=	.0400	0.235	=	.0400	3.25	=	.0400	2.95	=	.0400		ND
POTASSIUM, TOTAL	E200.7	mg/L	5.00		ND	5.00	13.1	=	5.00		ND	5.00	52.1	=	5.00	51.5	=	5.00		ND
MAGNESIUM, TOTAL	E200.7	mg/L	.200	59.7	=	.200	45.4	=	.200	43.3	=	.200	37.9	=	.200	37.8	=	.200	34.7	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.944	=	.0100	0.187	=	.0100	0.394	=	.0100	1.37	=	.0100	1.39	=	.0100	0.197	=
SODIUM, TOTAL	E200.7	mg/L	.900	16.9	=	.900	47.2	=	.900	46.4	=	.900	36.2	=	.900	36.1	=	.900	23.5	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.019	=	.0150		ND	.0150		ND	.0150	0.016	=	.0150		ND	.0150	0.035	=
SILICON, TOTAL	E200.7	mg/L	.300	3.31	=	.300	3.3	=	.300	5.79	=	.300	5.43	=	.300	5.32	=	.300	5.96	=
ZINC, TOTAL	E200.7	mg/L	.0100	0.018	=	.0100	0.011	=	.0100	0.011	=	.0100	0.014	=	.0100	0.014	=	.0100		ND
ALKALINITY	A403	mg/L	10	630	=	10	430	=	10	530	=	10	460	=	10	450	=	10	390	=
COD	A508A	mg/L	5		HT	5		HT	5		HT	5	56	=	5	64	=	5	18	=
FLUORIDE	E340.2	mg/L	0.1	0.2	=	0.1	0.4	=	0.1	0.4	=	0.1	0.2	=	0.1	0.2	=	0.1	0.3	=
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1		ND	0.2		ND	0.1		ND	0.1		ND	0.1	0.2	=
AMMONIA	E350.3	mg/L	0.1	0.3	=	0.1	4.2	=	0.1	0.6	=	0.1	3.2	=	0.1	3.4	=	0.1	0.5	=
TOC	E415.1	mg/L	1	20	=	1	12	=	1	3.6	=	1	20	=	1	20	=	1	4.6	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	1200	=	10	710	=	10	680	=	10	690	=	10	710	=	10	460	=
	SAMPLE # / RFW # / SAMPLE DATE		06-108-M001 / 8804-053-001 / 08-APR-88			06-109-M001 / 8804-053-002 / 08-APR-88			06-110-M001 / 8804-053-003 / 08-APR-88			06-144-M001 / 8804-053-010 / 09-APR-88			06-144-M101 / 8804-053-011 / 09-APR-88			06-146-M001 / 8804-069-002 / 11-APR-88		
CHLORIDE	A429	mg/L	2.5	10.9	=	2.5	30.9	=	25	40	=	2.5	6.1	=	2.5	7.1	=	2.5	8	=
SULFATE	A429	mg/L	50	432	=	25	209	=	25	137	=	2.5		ND	25		ND	25	82.6	=
	SAMPLE # / RFW # / SAMPLE DATE		06-108-M021 / 137199 / 07-AUG-88			06-109-M001 / 137198 / 07-AUG-88			06-110-M001 / 137197 / 07-AUG-88						06-108-M121 / 137200 / 07-AUG-88					
COD	A508A	mg/L	5	80	=	5	290	=	5	540	=				5	250	=			

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTION AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-58

(CONTINUED)

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL
	SAMPLE #		06-245-M001			06-247-M001		
	RFW #		127953			127809		
	SAMPLE DATE		10-APR-88			08-APR-88		
BUTYL BENZYL PHTHALATE	E625	ug/L	10	1	<	9		ND
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10	5	<	9	9	=
DI-N-BUTYL PHTHALATE	E625	ug/L	10	1	<	9		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.11		ND	1.01		NV
ALUMINUM, TOTAL	E200.7	mg/L	.200	0.33	=	.200		ND
ARSENIC,TOTAL	E200.7	mg/L	.0050		ND	.0050	0.01	=
BORON, TOTAL	E200.7	mg/L	.100	0.321	=	.100	0.163	=
BARIUM, TOTAL	E200.7	mg/L	.0500		ND	.0500	0.207	=
CALCIUM, TOTAL	E200.7	mg/L	.200	21.6	=	.200	94.9	=
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND
IRON, TOTAL	E200.7	mg/L	.0400	0.33	=	.0400	1.15	=
POTASSIUM, TOTAL	E200.7	mg/L	5.00	6.46	=	5.00		ND
MAGNESIUM, TOTAL	E200.7	mg/L	.200	7	=	.200	42.4	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.033	=	.0100	0.185	=
SODIUM, TOTAL	E200.7	mg/L	.900	87.4	=	.900	42.4	=
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150		ND
SILICON, TOTAL	E200.7	mg/L	.300	4.78	=	.300	7.56	=
ZINC, TOTAL	E200.7	mg/L	.0100	0.011	=	.0100	0.011	=
ALKALINITY	A403	mg/L	10	210	=	10	440	=
COD	A508A	mg/L	5	330	=	5		HT
FLUORIDE	E340.2	mg/L	0.1	1	=	0.1	0.6	=
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1		ND
AMMONIA	E350.3	mg/L	0.1	1.5	=	0.1	0.9	=
TOC	E415.1	mg/L	1	10	=	1	3.8	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	640	=	10	590	=
	SAMPLE #		06-245-M001			06-247-M001		
	RFW #		8804-069-001			8804-053-006		
	SAMPLE DATE		10-APR-88			08-APR-88		
CHLORIDE	A429	mg/L	2.5	34.4	=	2.5	17.8	=
SULFATE	A429	mg/L	25	85.2	=	12.5	108	=
	SAMPLE #					06-247-M021		
	RFW #					137196		
	SAMPLE DATE					07-AUG-88		
COD	A508A	mg/L				5	56	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTION AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
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= - CONCENTRATION SHOWN IS VALID

metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, COD, TOC, alkalinity, and TDS. Holding times were exceeded for TDS analyses for all the surface water samples and COD in sample 06-520-W002. The surface water stations were resampled on 3 August 1988 (wet event) and on 8 August 1988 (dry event). No holding times were exceeded for these resampled analytes.

Surrogate recoveries for purgeable halocarbons analyses ranged from 70 to 275 percent. Surrogate recoveries for purgeable aromatics ranged from 69 to 103 percent. Semivolatile surrogate recoveries ranged from 33 to 91 percent. All surrogate recoveries and detection limits were within quality control limits.

Table 4-59 lists the valid analytes and concentrations detected in surface water collected at NWLF. No purgeable halocarbons or purgeable aromatic compounds were detected in surface water samples. Semivolatile organic analytes naphthalene (<2 ug/L) and butyl benzyl phthalate (<4 ug/L) were detected in 06-519-W001 and semivolatile analyte di-n-butyl phthalate (<1 ug/L) in 06-519-W002. In addition, petroleum hydrocarbons (1.7 mg/L) were detected in 06-519-W001. Additional concentrations of petroleum hydrocarbons detected in the wet-event surface water samples were invalidated by petroleum hydrocarbons in corresponding quality control blanks.

Barium (0.051 mg/L) was detected at background concentrations in samples taken from surface water station 06-519. Analyses of samples taken from 06-520 detected a number of heavy metals in both dry- and wet-event samples, including arsenic (0.03 to 0.242 mg/L), barium (0.207 to 1.31 mg/L), cadmium (ND to 0.020 mg/L), chromium (0.029 to 0.188 mg/L), copper (0.054 to 0.238 mg/L), nickel (0.042 to 0.269 mg/L), lead (0.056 to 0.592 mg/L), vanadium (0.045 to 0.287 mg/L), and zinc (0.143 to 0.943 mg/L). The larger of each of the two values is the concentration detected in the wet-event sample (06-520-W002).

Chloride (3.3 to 85 mg/L) and sulfate (13.3 to 80 mg/L) were detected within background concentrations for dry and wet events. Nitrate/nitrite concentrations ranged from 0.6 to 1.6 mg/L. TDS (240 to 640 mg/L) and alkalinity (180 to 320 mg/L) also occurred within background concentrations. TOC concentrations ranged from 7.7 mg/L in 06-520-W001 to 34 mg/L in 06-519-W001. The two dry-event surface water samples had COD concentrations of 160 mg/L, well above the background range of 50 mg/L.

4.9.3 Extent of Contamination -- NWLF

Chemical analyses of the soils during the IRP Stage 2 investigation detected trace concentrations of one solvent, 2-butanone (0.019 mg/kg), in sample 06-345-B001 and petroleum

TABLE 4-59

VALID ANALYTES DETECTED IN DRY- AND WET-EVENT SURFACE WATER AT NWLF, IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # / RFW # / SAMPLE DATE		06-519-W001 128942 DRY EVENT 20-APR-88			06-520-W001 128943 DRY EVENT 20-APR-88			06-519-W002 130206 WET EVENT 10-MAY-88			06-520-W002 130207 WET EVENT 10-MAY-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
BUTYL BENZYL PHTHALATE	E625	ug/L	10	4	<	12		ND	9		ND	10		ND
DI-N-BUTYL PHTHALATE	E625	ug/L	10		ND	12		ND	9	1	<	10		ND
NAPHTHALENE	E625	ug/L	10	2	<	12		ND	9		ND	10		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.02	1.7	=	1.03		ND	1.02		HT	1.04		HT
ALUMINUM, TOTAL	E200.7	mg/L	.200		ND	.200	21.9	=	.200		ND	.200	146	=
ARSENIC, TOTAL	E200.7	mg/L	.0500		ND	.0100	0.03	=	.0500		ND	.100	0.242	=
BORON, TOTAL	E200.7	mg/L	.100	0.252	=	.100		ND	.100		ND	.100	0.309	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.051	=	.0500	0.207	=	.0500		ND	.0500	1.31	=
CALCIUM, TOTAL	E200.7	mg/L	.200	112	=	.200	104	=	.200	95.6	=	.200	500	=
CADMIUM, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050	0.02	=
COBALT, TOTAL	E200.7	mg/L	.0400		ND	.0400		ND	.0400		ND	.0400	0.099	=
CHROMIUM, TOTAL	E200.7	mg/L	.0100		ND	.0100	0.029	=	.0100		ND	.0100	0.188	=
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250	0.054	=	.0250		ND	.0250	0.238	=
IRON, TOTAL	E200.7	mg/L	.0400	1.72	=	.0400	28.6	=	.0400	1.02	=	.0400	204	=
POTASSIUM, TOTAL	E200.7	mg/L	5.00	7.77	=	5.00	7.13	=	5.00	9.08	=	5.00	24.6	=
MAGNESIUM, TOTAL	E200.7	mg/L	.200	27.7	=	.200	30.1	=	.200	23.3	=	.200	168	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	0.404	=	.0100	0.935	=	.0100	0.306	=	.0100	7.78	=
SODIUM, TOTAL	E200.7	mg/L	.900	39.6	=	.900	6.33	=	.900	37.6	=	.900	5.9	=
NICKEL, TOTAL	E200.7	mg/L	.0150		ND	.0150	0.042	=	.0150		ND	.0150	0.269	=
LEAD, TOTAL	E200.7	mg/L	.0100		ND	.0250	0.056	=	.0100		ND	.100	0.592	=
SILICON, TOTAL	E200.7	mg/L	300	4.56	=	300	21.9	=	300	4.27	=	300	32.5	=
VANADIUM, TOTAL	E200.7	mg/L	.0400		ND	.0400	0.045	=	.0400		ND	.0400	0.287	=
ZINC, TOTAL	E200.7	mg/L	.0100	0.042	=	.0100	0.143	=	.0100	0.044	=	.0100	0.943	=
ALKALINITY	A403	mg/L	10	320	=	10	180	=	10	310	=	10	210	=
COD	A508A	mg/L	5	160	=	5	160	=	5	80	=	5		NV
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV
NITRATE/NITRITE	E353.1	mg/L	0.1	0.6	=	0.1	1.1	=	0.1	1.6	=	0.1	1.3	=
AMMONIA	E350.3	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV
TOC	E415.1	mg/L	2	34	=	1.0	7.7	=	1.0	24	=	1.0	12	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT
	SAMPLE # / RFW # / SAMPLE DATE		06-519-W001 8804-183-034 20-APR-88			06-520-W001 8804-183-035 20-APR-88			06-519-W002 8805-386-019 10-MAY-88			06-520-W002 8805-386-020 10-MAY-88		
CHLORIDE	A429	mg/L	25	51.1	=	2.5	3.3	=	2.5	85	=	2.5	4.5	=
SULFATE	A429	mg/L	2.5	22.8	=	2.5	13.3	=	25	80	=	25	35.5	=
	SAMPLE # / RFW # / SAMPLE DATE		06-519-W021 137325 08-AUG-88			06-520-W021 137326 08-AUG-88			06-519-W022 136839 03-AUG-88			06-520-W022 136840 03-AUG-88		
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	640	=	10	240	=	10	530	=	10	280	=
	SAMPLE # / RFW # / SAMPLE DATE								06-519-W022 137218 06-AUG-88			06-520-W022 136840 03-AUG-88		
PETROLEUM HYDROCARBONS	E418.1	mg/L							1.20		NV	1.04		NV

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hydrocarbons (96 mg/kg) in sample 06-347-B001. Among the heavy metals regulated by drinking water standards, only nickel (41.8 mg/kg) in sample 06-347-B001 occurred above background concentrations. These samples were taken from locations just to the west and to the northeast of the borrow pit. No visible waste was observed in these samples. The analyses indicate that the soils around the pit exhibit trace contamination.

The Phase II Stage 1 investigation detected some evidence of groundwater contamination in all three monitor wells sampled around NWLF during that study. In monitor wells 06-109 and 06-110, oil and grease (1.55 and 3.7 mg/L), COD (565 and 320 mg/L), and copper (1.1 and 1.6 mg/L) were detected. Lead was detected in monitor wells 06-108 (0.024 mg/L) and 06-110 (0.011 mg/L) and total phenolics in wells 06-108 (15 ug/L) and 06-109 (13 ug/L). The volatile organic compound trichlorofluoromethane (2.2 ug/L) was detected in well 06-108.

The IRP Stage 2 investigation detected some confirmatory evidence of contamination. The COD concentrations were above background levels in monitor wells 06-109 (290 mg/L), 06-110 (540 mg/L), and 06-245 (330 mg/L). Sulfate occurred above background levels in wells 06-108 (432 mg/L) and 06-109 (209 mg/L). The concentration in monitor well 06-108 exceeds secondary drinking water standards for sulfate. Arsenic (0.010 mg/L), nickel (0.016 to 0.035 mg/L), and copper (0.033 mg/L) were detected in monitor wells 06-108, 06-144, 06-146, and 06-247. No metals concentrations exceeded primary or secondary drinking water standards. No volatile organics or semivolatile organics were detected in any IRP Stage 2 investigative groundwater sample, except some trace quantities of common plasticizers (phthalates) that may be a result of sampling, shipping, or analysis procedures.

Although a distinctive pattern emerges from the contamination profile, the shallow well had trace concentrations of arsenic, nickel, lead, and copper. Shallow wells directly to the southeast and west of NWLF also contain slightly elevated concentrations of TDS, alkalinity, sulfate, and COD. Shallow groundwater flow is to the south and southeast of the potentiometric high east of NWLF and to the north and west north of the potentiometric high (see Figure 4-62 and 4-63). The groundwater flow direction supports that the indicator parameters in the shallow monitor wells 06-110 and 06-109 are from landfill leachate or groundwater from the landfill. The seep near 06-109 appears to be a leachate seep, although it has not been analyzed. The parameters indicate increased anion concentrations in the groundwater. Therefore, it is possible that some mobilization of heavy metals is occurring in the buried waste due to hydrolysis, elimination, and chelation reactions. Organic contaminants, such as chlorinated solvents reported to have been placed in NWLF, were not detected.

Calculations of metals migration rates from NWLF are based upon a maximum shallow groundwater velocity (1 August 1988) calculation of 7.16 ft/year. NWLF was in use from 1955 to 1975. The maximum duration of travel time for any contaminant is 33 years. The maximum extent of a contaminant plume would, therefore, be 236 feet if the metals did not interact with the soil. The estimated organic contaminant plume extent, based upon retardation equation calculations (see Subsection 4.2.2.4), is approximately 104 feet (based upon a K_d of 0.1, bulk density of 2.1, porosity of 0.15, and carbon content of 0.1 percent).

Surface waters from NWLF were not sampled during the Phase II Stage 1 investigation. The IRP Stage 2 investigation sampled two stormwater sewers, one to the southeast (06-520) and one to the southwest (06-519) of NWLF. Station 06-519 exhibited mild organic compound contamination, with petroleum hydrocarbons (1.7 mg/L), naphthalene (<2 ug/L), butyl benzyl phthalate (<4 ug/L) detected during the dry event, and di-n-butyl phthalate (<1 ug/L) detected during the wet event. Both stations contained COD levels (160 mg/L) above background levels from the dry-event sampling. No other indicator parameter was above background level in the surface water samples. The most significant contamination in surface water samples collected from station 06-520 during both wet and dry events was metals contamination. These samples contained arsenic, barium, cadmium, chromium, copper, nickel, lead, vanadium, and zinc. Several of the metals were detected at concentrations above drinking water standards, including arsenic (0.242 mg/L), barium (1.31 mg/L), cadmium (0.020 mg/L), chromium (0.188 mg/L), and lead (0.592 mg/L). The results of these analyses may reflect true concentrations as a result of very low flow at these stormwater sampling stations during both dry and wet events and the associated difficulty in obtaining clear surface water samples with no sediments (all surface water samples were analyzed unfiltered). However, as this station is part of the stormwater drainage system that may receive leachate water from a seep near monitor well 06-109, the metals concentrations in the samples may be due to mobilized contaminants from NWLF. The network of stormwater sewers that drains the NWLF empties to a lift station north of TCLF that discharges into Lake St. Clair. Therefore, any contaminants in surface water from NWLF are discharged to Lake St. Clair.

No analyte concentrations exceeded applicable standards in soils at NWLF. Standards for organic analytes butyl benzyl phthalate, bis(2-ethylhexyl) phthalate, and di-n-butyl phthalate in groundwater were exceeded (see Table 4-60). The inorganic analytes arsenic, copper, iron, nickel, ammonia, and TDS exceeded several standards in groundwater. Arsenic, copper, and nickel exceeded EPA ambient water quality criteria and Clean Water Act standards (see Table 4-60).

Analytes in surface water (dry and wet event) exceeding standards included butyl benzyl phthalate, di-n-butyl phthalate

Table 4-60

Analyte Concentrations in NWLF Groundwater Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Butyl benzyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
06-146-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
06-245-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
Bis(2-ethylhexyl) phthalate		6×10^{-4}	N/A	N/A	N/A	N/A	N/A
06-108-M001	$<3 \times 10^{-3}$	X	---	---	---	---	---
06-109-M001	$<5 \times 10^{-3}$	X	---	---	---	---	---
06-110-M001	$<3 \times 10^{-3}$	X	---	---	---	---	---
06-144-M001	$<5 \times 10^{-3}$	X	---	---	---	---	---
06-144-M101	$<1 \times 10^{-3}$	X	---	---	---	---	---
06-146-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
06-245-M001	$<5 \times 10^{-3}$	X	---	---	---	---	---
06-247-M001	9×10^{-3}	X	---	---	---	---	---
Di-n-butyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
06-108-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
06-109-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
06-144-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
06-144-M101	$<3 \times 10^{-3}$	X	---	---	---	---	---
06-245-M001	$<1 \times 10^{-3}$	X	---	---	---	---	---
Arsenic		N/A	N/A	N/A	N/A	N/A	2.2×10^{-5}
06-144-M001	1×10^{-2}	---	---	---	---	---	X
06-247-M001	1×10^{-2}	---	---	---	---	---	X

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-60
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Butyl benzyl phthalate		N/A	N/A	N/A	N/A	N/A
06-146-M001	$<1 \times 10^{-3}$	---	---	---	---	---
06-245-M001	$<1 \times 10^{-3}$	---	---	---	---	---
Bis(2-ethylhexyl) phthalate		N/A	N/A	N/A	N/A	N/A
06-108-M001	$<3 \times 10^{-3}$	---	---	---	---	---
06-109-M001	$<5 \times 10^{-3}$	---	---	---	---	---
06-110-M001	$<3 \times 10^{-3}$	---	---	---	---	---
06-144-M001	$<5 \times 10^{-3}$	---	---	---	---	---
06-144-M101	$<1 \times 10^{-3}$	---	---	---	---	---
06-146-M001	$<1 \times 10^{-3}$	---	---	---	---	---
06-245-M001	$<5 \times 10^{-3}$	---	---	---	---	---
06-247-M001	9×10^{-3}	---	---	---	---	---
Di-n-butyl phthalate		N/A	N/A	N/A	N/A	N/A
06-108-M001	$<1 \times 10^{-3}$	---	---	---	---	---
06-109-M001	$<2 \times 10^{-3}$	---	---	---	---	---
06-144-M001	$<2 \times 10^{-3}$	---	---	---	---	---
06-144-M101	$<3 \times 10^{-3}$	---	---	---	---	---
06-245-M001	$<1 \times 10^{-3}$	---	---	---	---	---
Arsenic		2.5×10^{-5}	N/A	N/A	N/A	N/A
06-144-M001	1×10^{-2}	X	---	---	---	---
06-247-M001	1×10^{-2}	X	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-60
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Copper		5×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
06-146-M001	3.3×10^{-2}	X	---	---	X	X	---
Iron		3×10^{-1}	N/A	N/A	N/A	N/A	N/A
06-144-M001	3.25	X	---	---	---	---	---
06-144-M101	2.95	X	---	---	---	---	---
06-245-M001	3.3×10^{-1}	X	---	---	---	---	---
06-247-M001	1.15	X	---	---	---	---	---
Nickel		2.5×10^{-2}	N/A	N/A	N/A	N/A	1.34×10^{-2}
06-108-M001	1.9×10^{-2}	---	---	---	---	---	X
06-144-M001	1.6×10^{-2}	---	---	---	---	---	X
06-146-M001	3.5×10^{-2}	X	---	---	---	---	X
Ammonia		5×10^{-1}	N/A	N/A	N/A	N/A	N/A
06-109-M001	4.2	X	---	---	---	---	---
06-110-M001	6×10^{-1}	X	---	---	---	---	---
06-144-M001	3.2	X	---	---	---	---	---
06-144-M101	3.4	X	---	---	---	---	---
06-146-M001	5×10^{-1}	X	---	---	---	---	---
06-245-M001	1.5	X	---	---	---	---	---
06-247-M001	9×10^{-1}	X	---	---	---	---	---
TDS		2×10^{2}	N/A	N/A	N/A	N/A	N/A
06-108-M001	1.2×10^{3}	X	---	---	---	---	---
06-109-M001	7.1×10^{2}	X	---	---	---	---	---
06-110-M001	6.8×10^{2}	X	---	---	---	---	---
06-144-M001	6.9×10^{2}	X	---	---	---	---	---
06-144-M101	7.1×10^{2}	X	---	---	---	---	---
06-146-M001	4.6×10^{2}	X	---	---	---	---	---
06-245-M001	6.4×10^{2}	X	---	---	---	---	---
06-247-M001	5.9×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-60
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Copper		N/A	N/A	N/A	N/A	N/A
06-146-M001	3.3×10^{-2}	---	---	---	---	---
Iron		N/A	N/A	N/A	N/A	N/A
06-144-M001	3.25	---	---	---	---	---
06-144-M101	2.95	---	---	---	---	---
06-245-M001	3.3×10^{-1}	---	---	---	---	---
06-247-M001	1.15	---	---	---	---	---
Nickel		1.54×10^{-2}	N/A	N/A	N/A	N/A
06-108-M001	1.9×10^{-2}	X	---	---	---	---
06-144-M001	1.6×10^{-2}	X	---	---	---	---
06-146-M001	3.5×10^{-2}	X	---	---	---	---
Ammonia		N/A	N/A	N/A	N/A	N/A
06-109-M001	4.2	---	---	---	---	---
06-110-M001	6×10^{-1}	---	---	---	---	---
06-144-M001	3.2	---	---	---	---	---
06-144-M101	3.4	---	---	---	---	---
06-146-M001	5×10^{-1}	---	---	---	---	---
06-245-M001	1.5	---	---	---	---	---
06-247-M001	9×10^{-1}	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
06-108-M001	1.2×10^{3}	---	---	---	---	---
06-109-M001	7.1×10^{2}	---	---	---	---	---
06-110-M001	6.8×10^{2}	---	---	---	---	---
06-144-M001	6.9×10^{2}	---	---	---	---	---
06-144-M101	7.1×10^{2}	---	---	---	---	---
06-146-M001	4.6×10^{2}	---	---	---	---	---
06-245-M001	6.4×10^{2}	---	---	---	---	---
06-247-M001	5.9×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

arsenic, cadmium, chromium, copper, nickel, lead, and zinc (see Table 4-61). The cadmium concentration in sample 06-520-W001 exceeded the potential international chemical-specific ARARs, RCRA standards, Clean Water Act standards, EPA ambient water quality criterion standards, and Safe Drinking Water Act standards.

4.9.4 Qualitative Risk Assessment -- NWLF

Over 30 industrial chemical species were detected in subsurface soils, groundwater, and surface water at NWLF. From this total, nine contaminants of concern were identified using the EPA indicator chemical selection process and are listed in Table 4-62.

The following migration pathways for movement of contaminants from the site have been identified:

- Soil --> groundwater
- Soil --> groundwater --> stormwater drainage system --> surface water

Access to this site is not restricted or limited. It is estimated that over 100 persons are located within 1,000 feet of the site perimeter on a day-to-day basis, including hangar personnel and visitors to the Coast Guard Officers Club.

Soil contamination at NWLF occurs at low levels, with the exception of nickel, and is limited in the number of contaminants. Contamination is primarily subsurface and does not represent a direct contact hazard to base personnel. Exposure to airborne volatile contaminants released from the subsurface soils would not represent a hazard because of low levels of contamination, slow release, and rapid dilution of volatilized chemicals in air. The low concentrations of chemicals at NWLF would most likely not represent a hazard even if remedial activities exposed contaminated soils, but ambient air monitoring data would be necessary to confirm the level of hazard.

Surface water samples from NWLF were taken from the underlying base stormwater drainage systems. Indicator chemicals selected for these samples include metals, phthalates, ammonia, and napthalene. Several of the metals were present in concentrations that exceeded water quality standards or recommendations. Contaminated surface water is discharged by a pump lift station directly to Lake St. Clair.

Similar contaminants were found in the site groundwater at higher concentrations, but at levels below established criteria. Seepage of this groundwater into the stormwater drainage system would be the primary route for discharge into Lake St. Clair. Direct contact with groundwater prior to its seepage into the stormwater system is unlikely on base because there are no base water wells in use.

Table 4-61

Analyte Concentrations in NWLF Surface Water Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Butyl benzyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
06-519-W001	$<4 \times 10^{-3}$	X	---	---	---	---	---
Di-n-butyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
06-519-W002	$<1 \times 10^{-3}$	X	---	---	---	---	---
Arsenic		5×10^{-2}	N/A	5×10^{-2}	N/A	N/A	2.2×10^{-5}
06-520-W001	2.42×10^{-1}	X	---	X	---	---	X
Barium		N/A	N/A	1.0	N/A	N/A	N/A
06-520-W001	1.31	---	---	X	---	---	---
Cadmium		2×10^{-4}	N/A	1×10^{-2}	3.9×10^{-3}	1.1×10^{-3}	1.0×10^{-2}
06-520-W001	2×10^{-2}	X	---	X	X	X	X
Chromium		5×10^{-2}	N/A	5×10^{-2}	N/A	N/A	N/A
06-520-W001	1.88×10^{-1}	X	---	X	---	---	---
Copper		5×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
06-520-W001	5.4×10^{-2}	X	---	---	X	X	---
06-520-W002	2.38×10^{-1}	X	---	---	X	X	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-61
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Butyl benzyl phthalate						
06-519-W001	<4 × 10^{-3}	N/A ---	N/A ---	N/A ---	N/A ---	N/A ---
Di-n-butyl phthalate						
06-519-W002	<1 × 10^{-3}	N/A ---	N/A ---	N/A ---	N/A ---	N/A ---
Arsenic						
06-520-W001	2.42 × 10^{-1}	5 × 10^{-5} X	5 × 10^{-2} X	N/A ---	3 × 10^{-2} X	N/A ---
Barium						
06-520-W001	1.31	N/A ---	1.0 X	N/A ---	N/A ---	N/A ---
Cadmium						
06-520-W001	2 × 10^{-2}	1.2 × 10^{-2} X	1 × 10^{-2} X	N/A ---	5 × 10^{-3} X	5 × 10^{-3} X
Chromium						
06-520-W001	1.88 × 10^{-1}	N/A ---	5 × 10^{-2} X	N/A ---	1 × 10^{-1} X	N/A ---
Copper		N/A	N/A	N/A	N/A	N/A
06-520-W001	5.4 × 10^{-2}	---	---	---	---	---
06-520-W002	2.38 × 10^{-1}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-61
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Iron		3×10^{-1}	N/A	N/A	N/A	N/A	N/A
06-519-W001	1.72	X	---	---	---	---	---
06-520-W001	2.86×10^{1}	X	---	---	---	---	---
06-519-W002	1.02	X	---	---	---	---	---
06-520-W002	2.04×10^{2}	X	---	---	---	---	---
Nickel		2.5×10^{-2}	N/A	N/A	N/A	1.6×10^{-1}	1.34×10^{-2}
06-520-W001	4.2×10^{-2}	X	---	---	---	---	X
06-520-W002	2.69×10^{-1}	X	---	---	---	X	X
Lead		2.5×10^{-2}	N/A	5×10^{-2}	8.2×10^{-2}	3.2×10^{-3}	5×10^{-2}
06-520-W001	5.6×10^{-2}	X	---	X	X	X	X
06-520-W002	5.92×10^{-1}	X	---	X	X	X	X
Zinc		3×10^{-2}	N/A	N/A	N/A	N/A	N/A
06-519-W001	4.2×10^{-2}	X	---	---	---	---	---
06-520-W001	1.43×10^{-2}	X	---	---	---	---	---
06-519-W002	4.4×10^{-2}	X	---	---	---	---	---
06-520-W002	9.43×10^{-1}	X	---	---	---	---	---
TDS		2×10^{2}	N/A	N/A	N/A	N/A	N/A
06-519-W001	6.4×10^{2}	X	---	---	---	---	---
06-520-W001	2.4×10^{2}	X	---	---	---	---	---
06-519-W002	5.3×10^{2}	X	---	---	---	---	---
06-520-W002	2.8×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-61
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Iron		N/A	N/A	N/A	N/A	N/A
06-519-W001	1.72	---	---	---	---	---
06-520-W001	2.86×10^{1}	---	---	---	---	---
06-519-W002	1.02	---	---	---	---	---
06-520-W002	2.04×10^{2}	---	---	---	---	---
Nickel		1.54×10^{-2}	N/A	N/A	N/A	N/A
06-520-W001	4.2×10^{-2}	X	---	---	---	---
06-520-W002	2.69×10^{-1}	X	---	---	---	---
Lead		5×10^{-2}	5×10^{-2}	N/A	N/A	0
06-520-W001	5.6×10^{-2}	X	X	---	---	X
06-520-W002	5.92×10^{-1}	X	X	---	---	X
Zinc		N/A	N/A	N/A	N/A	N/A
06-519-W001	4.2×10^{-2}	---	---	---	---	---
06-520-W001	1.43×10^{-2}	---	---	---	---	---
06-519-W002	4.4×10^{-2}	---	---	---	---	---
06-520-W002	9.43×10^{-1}	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
06-519-W001	6.4×10^{2}	---	---	---	---	---
06-520-W001	2.4×10^{2}	---	---	---	---	---
06-519-W002	5.3×10^{2}	---	---	---	---	---
06-520-W002	2.8×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-62

Contaminants of Concern at NWLF, IRP Stage 2, Selfridge ANGB, MI

Contaminant	Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
	Maximum Concentration Detected in Medium		
2-Butanone	0.000019		
Acetone			
Ammonia[a]		4.2	
<u>Phthalates</u>			
Bis(2-ethylhexyl) phthalate		0.009	
Butyl benzyl phthalate[a]		0.001	0.004
Di-n-butyl phthalate		0.002	0.001
Cadmium[b]		0.002	0.00002
Nickel[b]	0.0431	0.035	0.269
<u>PAHs</u>			
Napthalene			0.002

[a]No Federal or state criteria exist at present for contaminant levels in groundwater or surface water.

[b]Known/suspected carcinogen (inhalation route).

4.10 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- EAST RAMP

4.10.1 Pathway Characterization and Migration Potential -- ERMP

4.10.1.1 Subsurface Conditions -- ERMP

Two soil borings drilled at ERMP, 07-428 and 07-429, were each advanced to a depth of 30 feet BLS. In the top 5 feet a thin topsoil layer and clayey silt fill were encountered. The clayey silt extended to a depth of 10 feet BLS in soil boring 07-429. Between 10 feet BLS and the bottom of the borehole a brown to gray silty clay was observed.

All OVA readings obtained from soil samples extracted from soil boring 07-428 were at background levels or within 0.5 unit of background levels. The background OVA reading at ERMP was 1 unit. OVA readings from soil samples obtained from soil boring 07-429 were above background levels in four of the six samples collected at the borehole; however, none of the readings exceeded 6 units. There were no visible signs of soil contamination observed, and no unusual odors were noted during drilling of the soil borings.

Gray clay to silty clay was the predominant lithology encountered in the groundwater monitor well borings at ERMP. Sample recovery in the initial 5 feet of material was less than 50 percent. Based upon the samples recovered, this interval was made up largely of clay, silt, and sand fill material.

Underlying the fill material is a mottled silt, with clay laminations, to a depth of 10 feet. Below this is a gray clay to silty clay to 25 feet BLS. From 25 to 30 feet a transition from the overlying gray clay to sandy clay was observed. Sandy clay to sand occurred in a 2- to 4-foot layer 35 feet BLS in most borings drilled to this depth. The exception was boring 07-243 where the gray clay extended to 37 feet.

All OVA readings of soil samples taken from 0 to 15 feet in the groundwater monitor well borings at ERMP were at the background level or within 0.5 unit of the background level. Readings from soil samples below 15 feet were commonly above background level, but generally below 10 units. Notable exceptions were the samples taken from two deep monitor well boreholes 07-239 and 07-241. The soil core from 30 to 35 feet in 07-239 registered from 50 units to >1,000 units. Measurements of 8 to 25 units and 8 to 75 units were obtained from the 25- to 30-foot and 30- to 35-foot samples, respectively, in 07-241. Elevated OVA readings are believed to be due to the presence of methane. There were no visible signs of contamination observed nor any unusual odors noted during drilling of the Stage 2 groundwater monitor well borings at ERMP.

Figures 4-66, 4-67, and 4-68 are geologic cross sections of ERMP constructed using boring log information. The trace of the

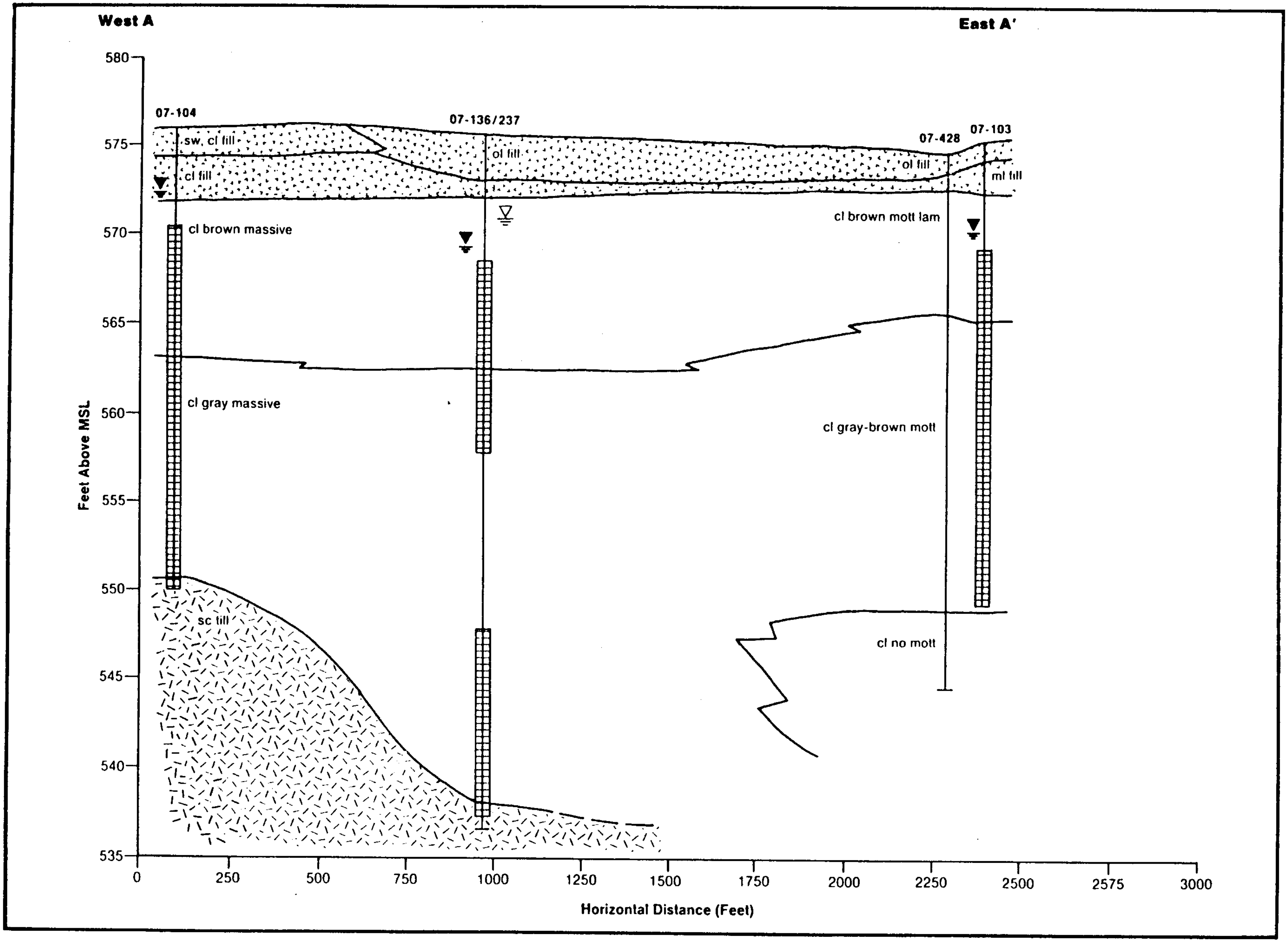


FIGURE 4-66 ERMP GEOLOGIC CROSS SECTION A-A'

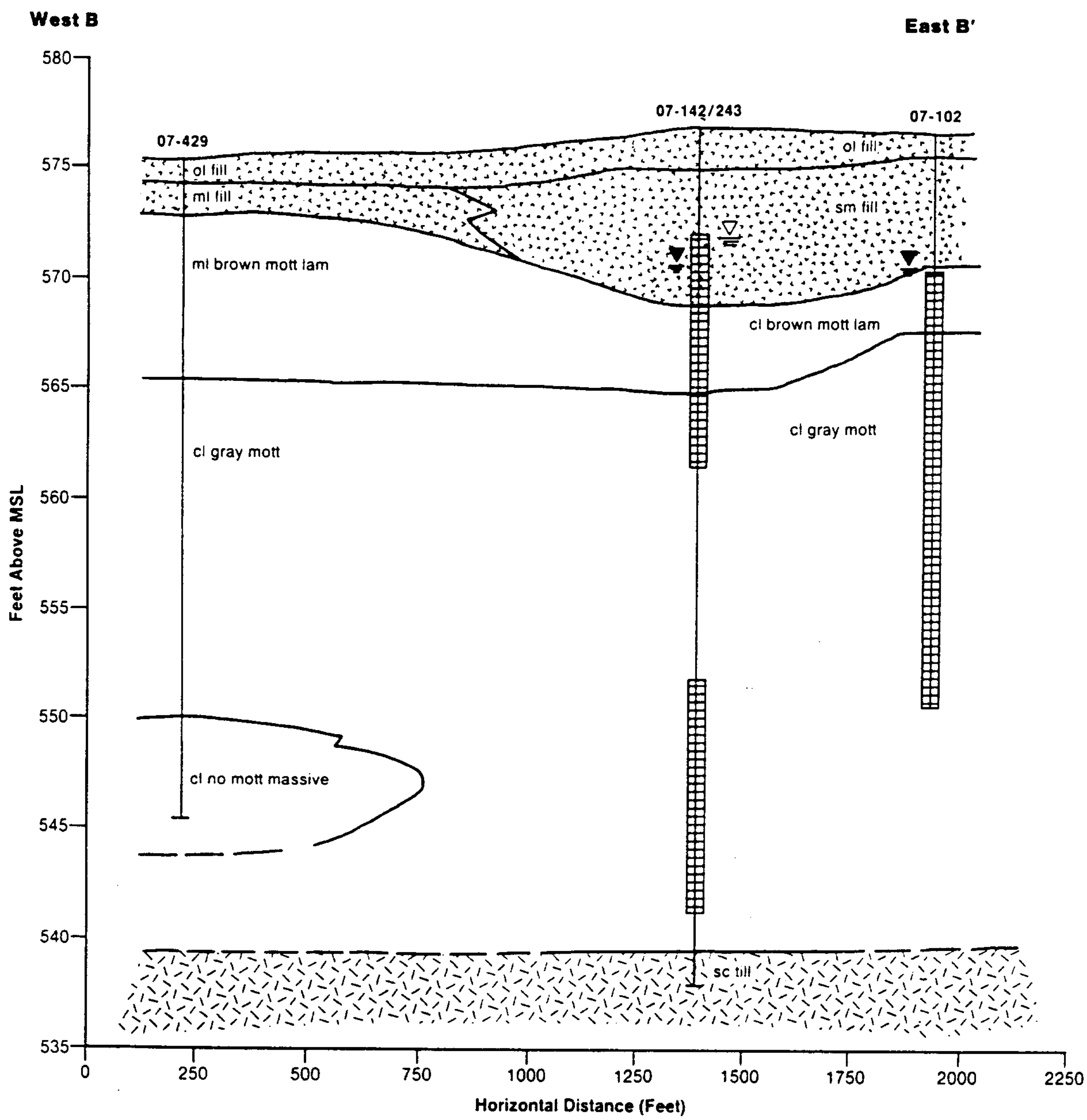


FIGURE 4-67 ERMP GEOLOGIC CROSS SECTION B-B'

WESTON

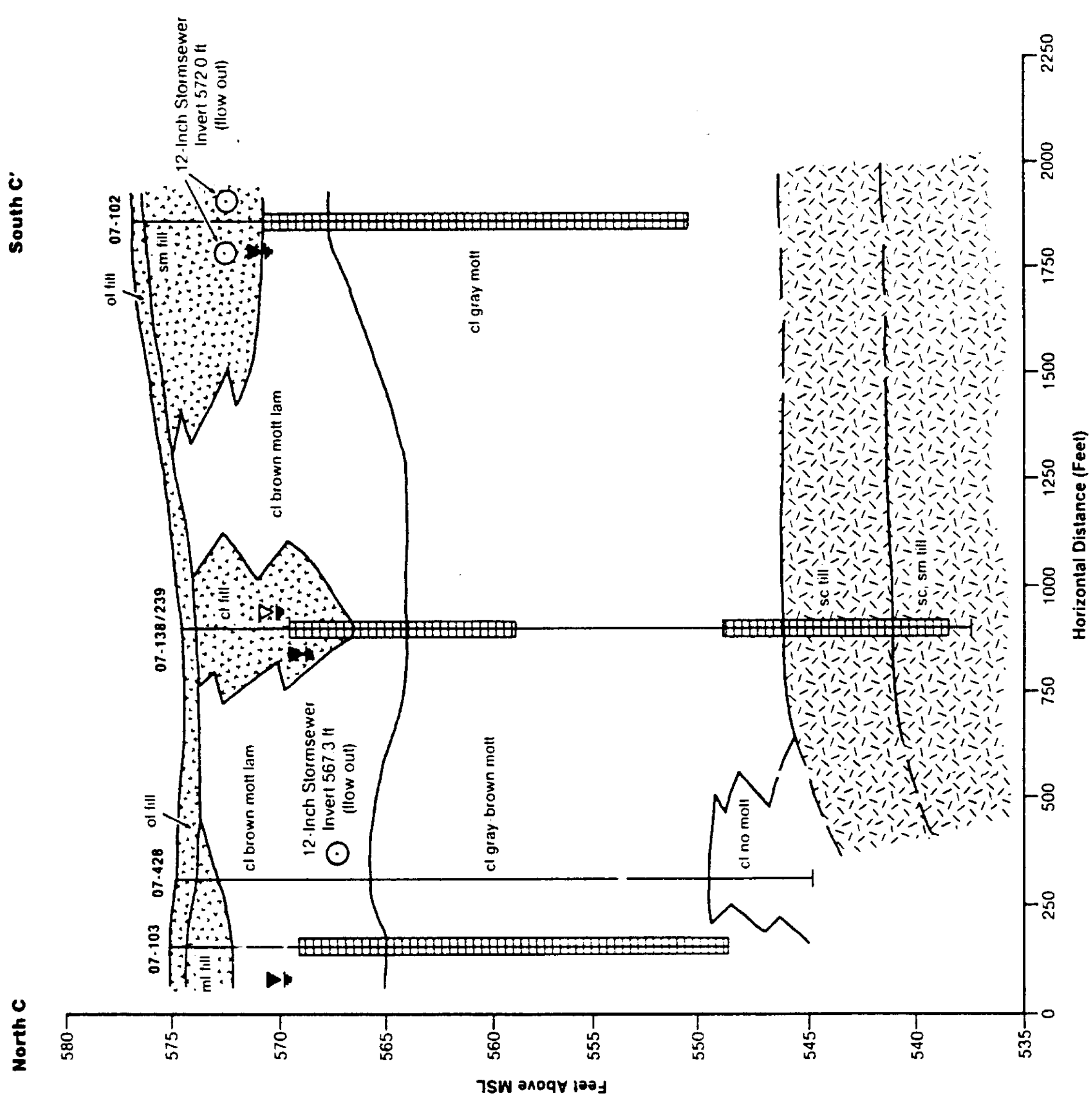


FIGURE 4-68 ERMP GEOLOGIC CROSS SECTION C-C'

cross sections is shown in Figure 4-69. Fill material comprises the upper 2 to 8 feet of material. Lacustrine clays, which represented the thickest sequence of natural sediments penetrated at the site and till units, were encountered at monitor well borings.

4.10.1.2 Extent and Character of Unsaturated Zone -- ERMP

The nature and extent of the unsaturated zone, as seen in Figures 4-66 and 4-68, varies as observed in soil and monitor well borings around the perimeter of the site. Unsaturated conditions occurred to a depth of 9 to 12 feet BLS. A thin topsoil layer covers the top of the unsaturated zone. Below this topsoil is fill material consisting of a mixture of clay, silt, sand, and gravel. Its thickness ranged from 1.5 feet at soil boring 07-429 to approximately 7 feet at monitor well boring 07-138.

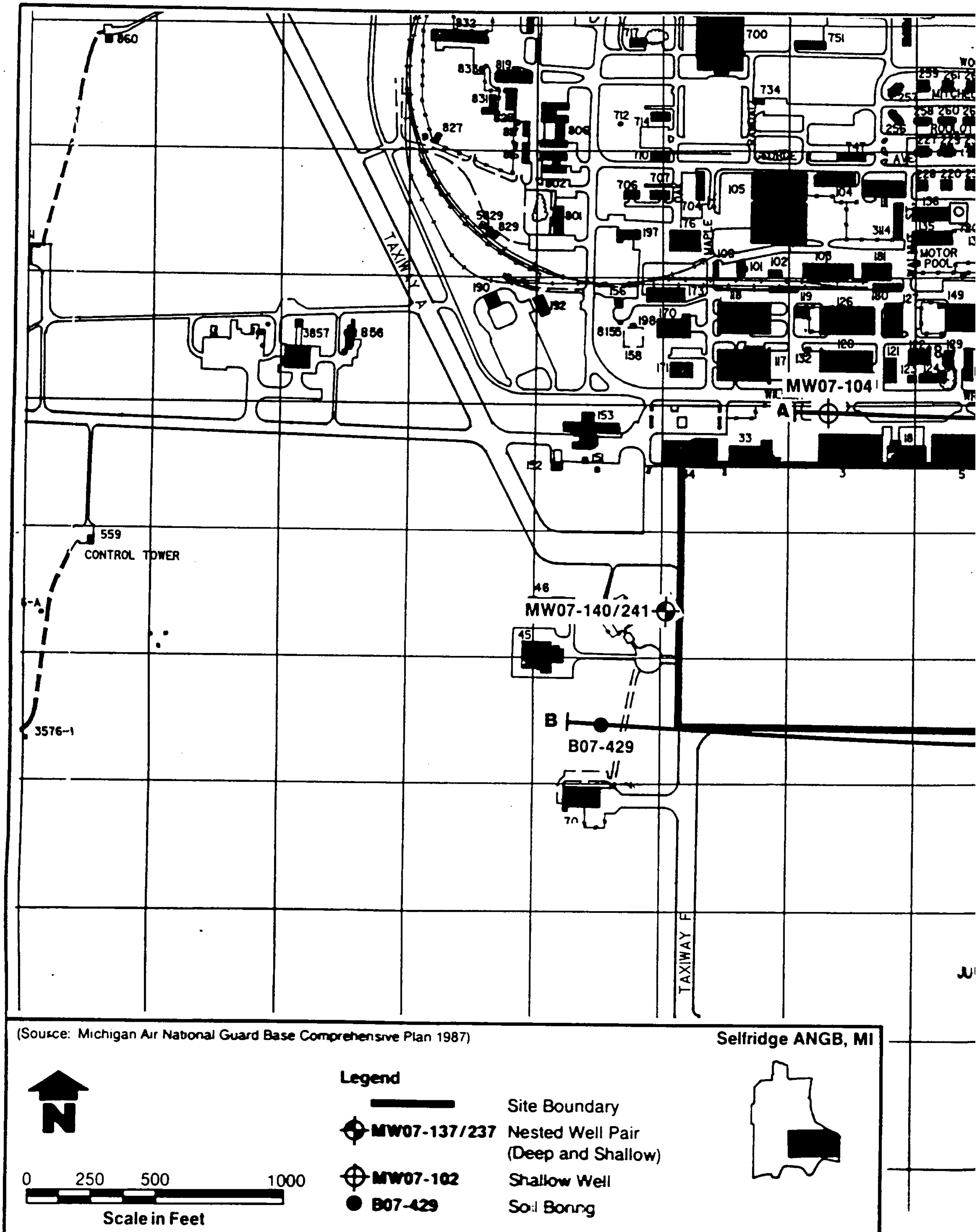
Fill material was added to the site prior to construction of the ERMP and support buildings. The fill served to raise the ground level and provide a base for construction. Below the fill material is the lacustrine unit which makes up the lower portion of the unsaturated zone to a depth of 9 to 12 feet BLS. Brown, iron-stained mottling was observed in the silty sand to silty clay of the lacustrine unit. Dry to moist conditions occur in the fill material and lacustrine sediments.

4.10.1.3 Groundwater Conditions -- ERMP

The top of the saturated zone was determined from visual observations made during drilling of soil and monitor well borings. In part the boundary between the unsaturated and saturated zone was identified by the change in the color of mottles from brown, iron-stained mottling in the unsaturated zone to gray mottling in the saturated zone. This boundary was also confirmed by the change from moist to wet conditions. The top of the saturated zone occurs at 9 to 12 feet BLS.

A total of seven partial or complete water level measurement rounds were taken between 1 February and 1 August 1988. During the 1 February 1988 period all monitor wells had not been installed. All monitor wells at ERMP were available for water level measurement after this time.

Generally, all monitor wells showed decreases in water level elevations during the period from 1 February to 1 August 1988. Only monitor well 07-241 had an increase in water elevation over this period. A comparison of monitor well water level elevations to the surface elevation of Lake St. Clair shows that the lake level is consistently higher. Monitor well 07-142 on 4 March and 21 March 1988 had the only water level elevations that were above the surface elevation of Lake St.



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW07-137/237 Nested Well Pair (Deep and Shallow)
MW07-102 Shallow Well
B07-429 Soil Boring
0 250 500 1000
Scale in Feet
N
MW07-104
MW07-140/241
B07-429
A
B
CONTROL TOWER
TAXIWAY A
TAXIWAY F
MAPLE
MOTOR POOL

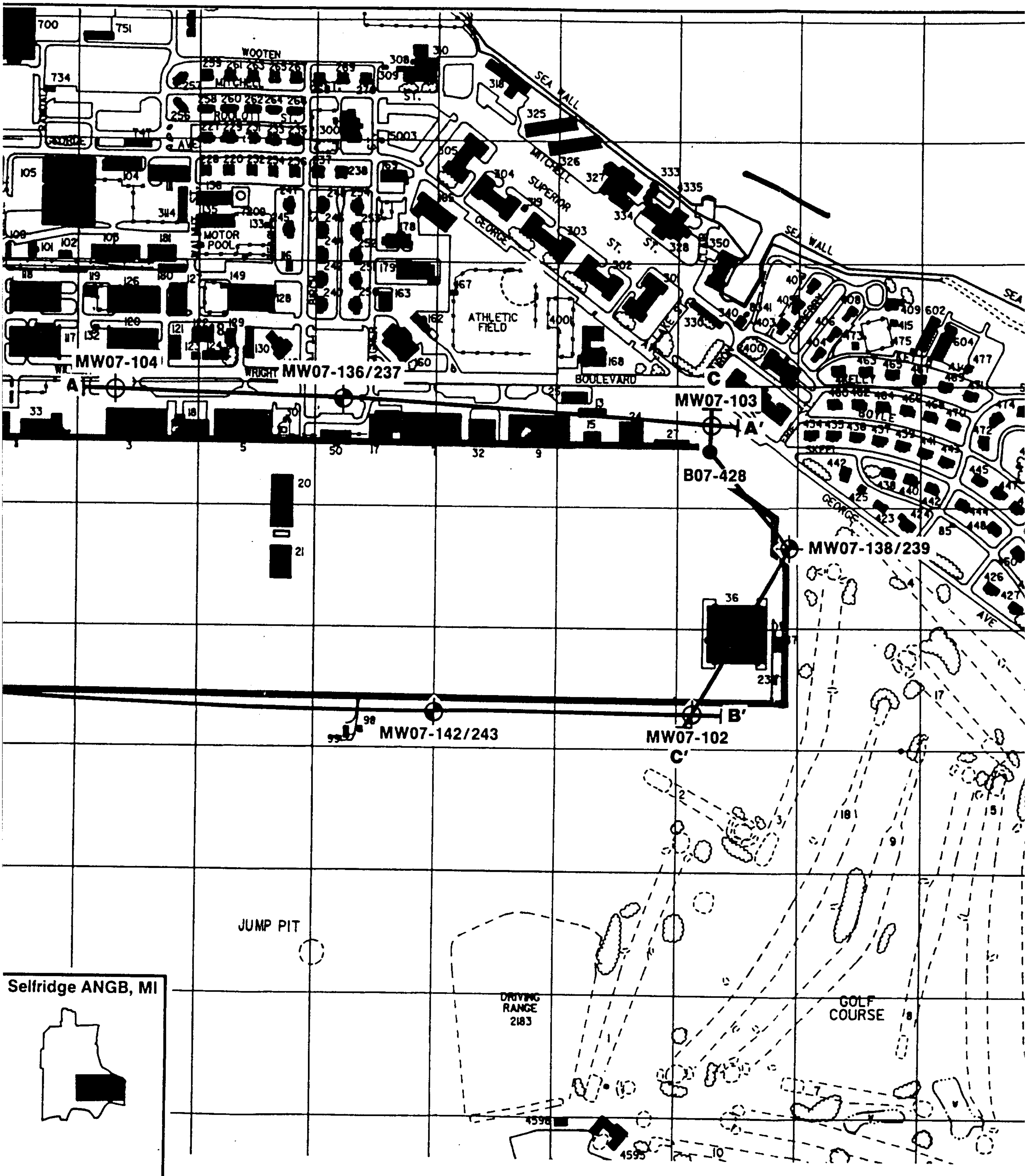


FIGURE 4-69 TRA
A-A',
AT E

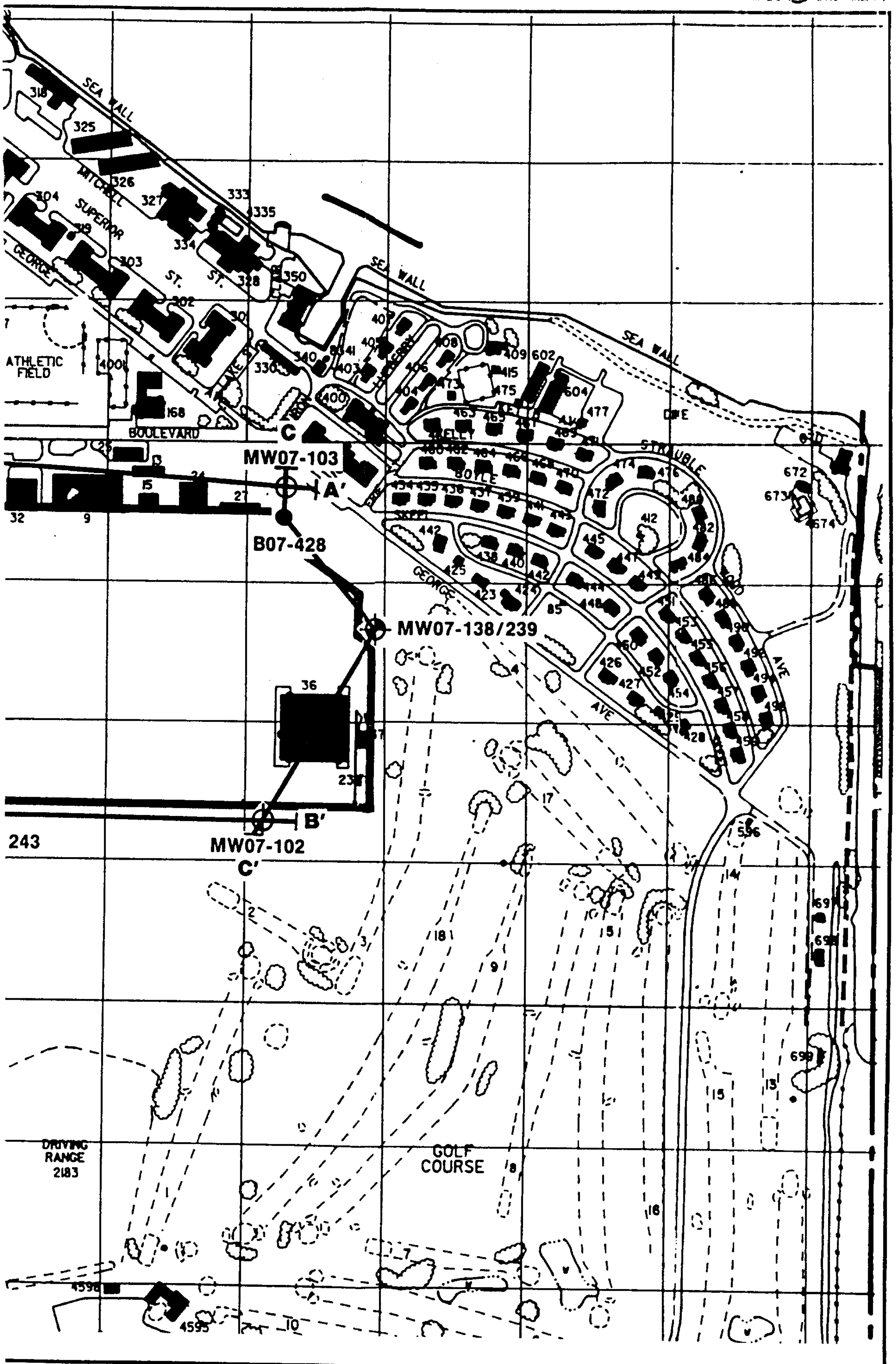


FIGURE 4-69 TRACE OF CROSS SECTION A-A', B-B', AND C-C' AT ERMP

Clair. On 21 March 1988 water levels in the monitor wells were between 1.09 and 5.67 feet below the surface elevation for Lake St. Clair. On 1 August 1988 the water levels in all monitor wells were 1.99 to 5.25 feet below the surface elevation of the lake.

The potentiometric surface map, based upon shallow monitor wells for the period 21 March 1988, is shown in Figure 4-70. Based upon this map, the groundwater flow along the southern portion of the site is toward the northeast, while near Lake St. Clair, groundwater flow is toward the base. Figure 4-70 shows a potentiometric trough north and east of the site.

Figure 4-71 shows the shallow monitor well potentiometric surface map for 1 August 1988. Groundwater flow remains approximately the same as on 21 March 1988, except that a groundwater sink exists in the area around monitor well 07-140.

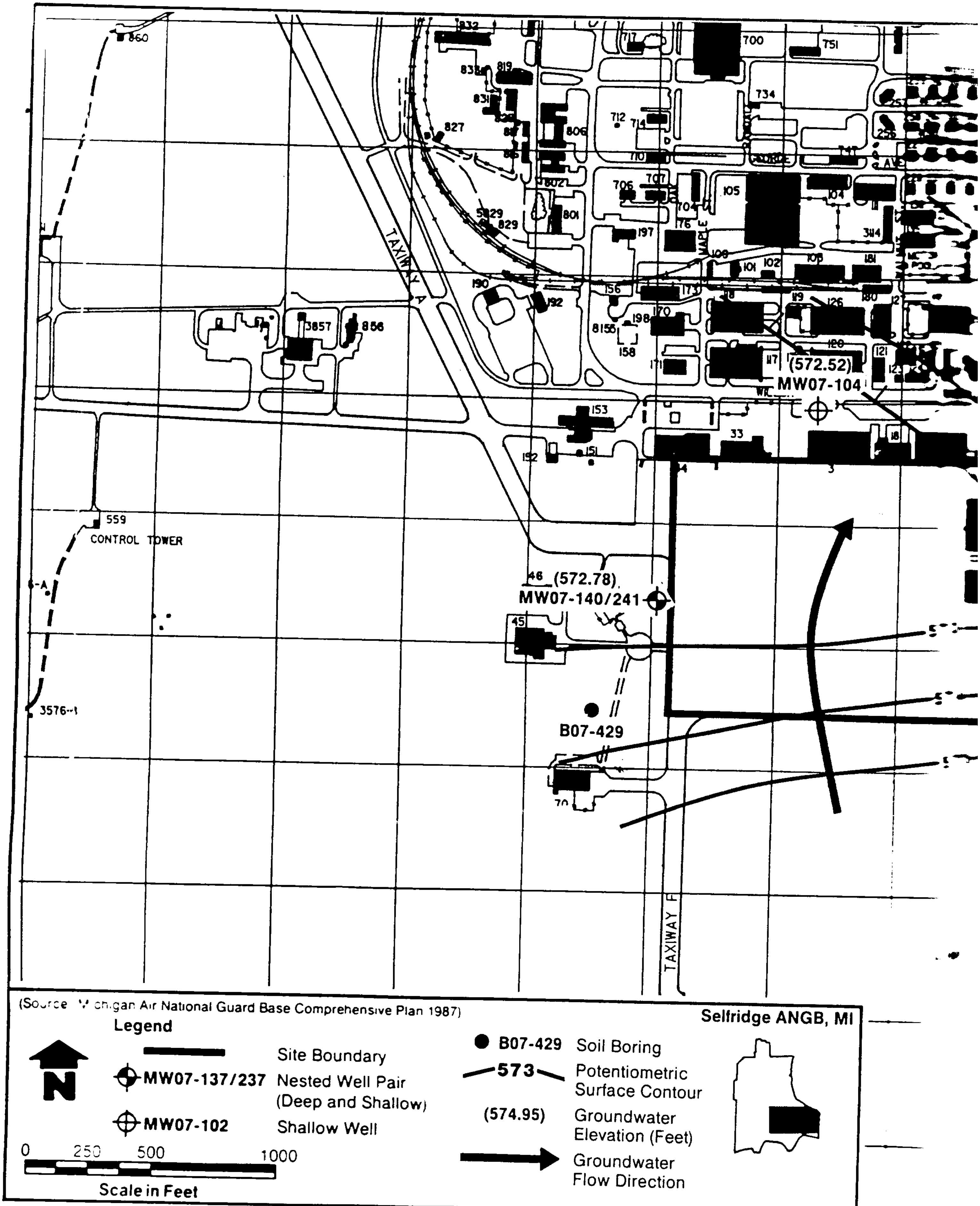
The deep monitor well potentiometric surface map for 21 March 1988 is shown in Figure 4-72. The groundwater flow, based upon this map, is from the north and south toward ERMP. Groundwater flow converges on a trough in the potentiometric surface. The deep monitor well potentiometric surface map for 1 August 1988 is presented in Figure 4-73. This map is similar to the one for 21 March 1988. A trough still exists in the potentiometric surface, but it is broader and more gentle.

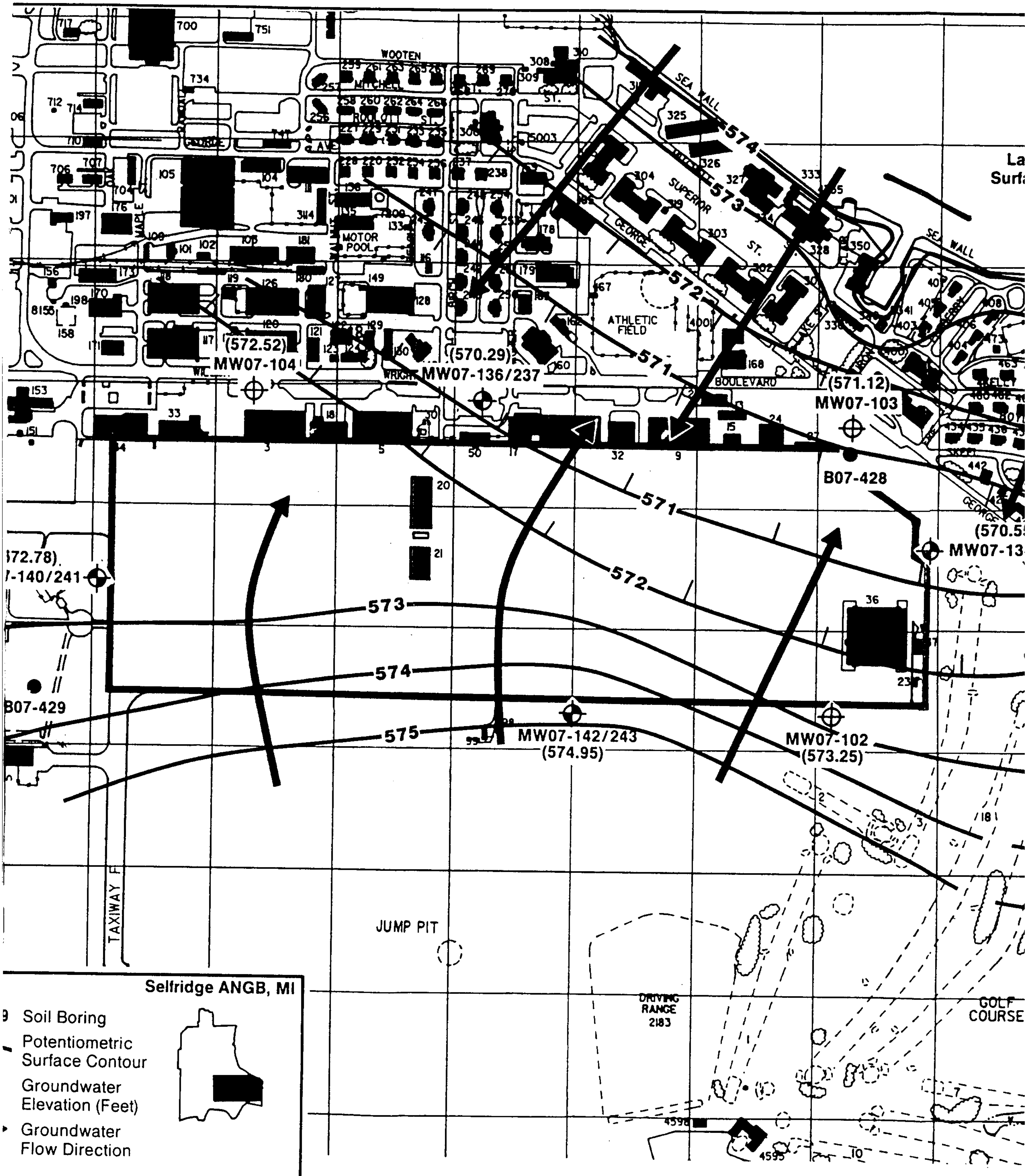
Figure 3-5 shows the location of the stormwater drainage system pipes and catch basins to the north and east of ERMP. The trough in the potentiometric surface appears to be a result of the stormwater drainage system intercepting groundwater.

Horizontal gradients of 0.004 ft/ft and 0.003 ft/ft were determine from the 21 March and 1 August 1988 shallow monitor well potentiometric maps, respectively. A gradient of 0.002 ft/ft was determined for the 21 March and 1 August 1988 deep monitor well potentiometric maps. Vertical gradients at ERMP are upward, based upon water levels measured at monitor well pairs.

Hydraulic conductivities (K) were determined using baildown recovery data for all monitor wells at ERMP. K values are reported in Table 3-18 for each monitor well. The average K value, based upon all ERMP monitor wells, was 4.60×10^{-6} ft/sec (1.40×10^{-4} cm/sec). ERMP shallow monitor wells have an average K value of 6.63×10^{-6} ft/sec (2.02×10^{-4} cm/sec). The deep monitor well average K value was 1.05×10^{-6} ft/sec (3.19×10^{-5} cm/sec). Using these K values the groundwater flow velocities for each water level measurement period can be calculated.

Based upon the horizontal gradient, the average shallow and deep monitor well hydraulic conductivity, and an effective


860
TAXIWAY A
CONTROL TOWER
559
3857
856
153
151
46 (572.78)
MW07-140/241
45
B07-429
70
(572.52)
MW07-104
33
TAXIWAY F
700
751
734
712
714
710
GEORGE AVE
706
707
105
104
704
76
MAPLE
197
801
802
806
819
827
829
832
831
838
106
101
102
103
181
190
192
156
173
118
119
126
180
198
170
8156
158
171
117
120
121
18
314
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Legend
Site Boundary
MW07-137/237 Nested Well Pair (Deep and Shallow)
MW07-102 Shallow Well
B07-429 Soil Boring
573 Potentiometric Surface Contour
(574.95) Groundwater Elevation (Feet)
Groundwater Flow Direction
0 250 500 1000
Scale in Feet
Selfridge ANGB, MI



Selfridge ANGB, MI
Soil Boring
Potentiometric Surface Contour
Groundwater Elevation (Feet)
Groundwater Flow Direction
MW07-104
(572.52)
MW07-136/237
(570.29)
MW07-103
(571.12)
B07-428
MW07-13
(570.5
(572.78)
7-140/241
B07-429
MW07-142/243
(574.95)
MW07-102
(573.25)
571
572
573
574
575
WOOTEN
MITCHELL
ROOLOT
GEORGE
AVE
ST.
SUPERIOR
SEA WALL
MAPLE
MOTOR POOL
ATHLETIC FIELD
BOULEVARD
WRIGHT
JUMP PIT
DRIVING RANGE 2183
GOLF COURSE
TAXIWAY F
La
Surf

FIGURE 4-7

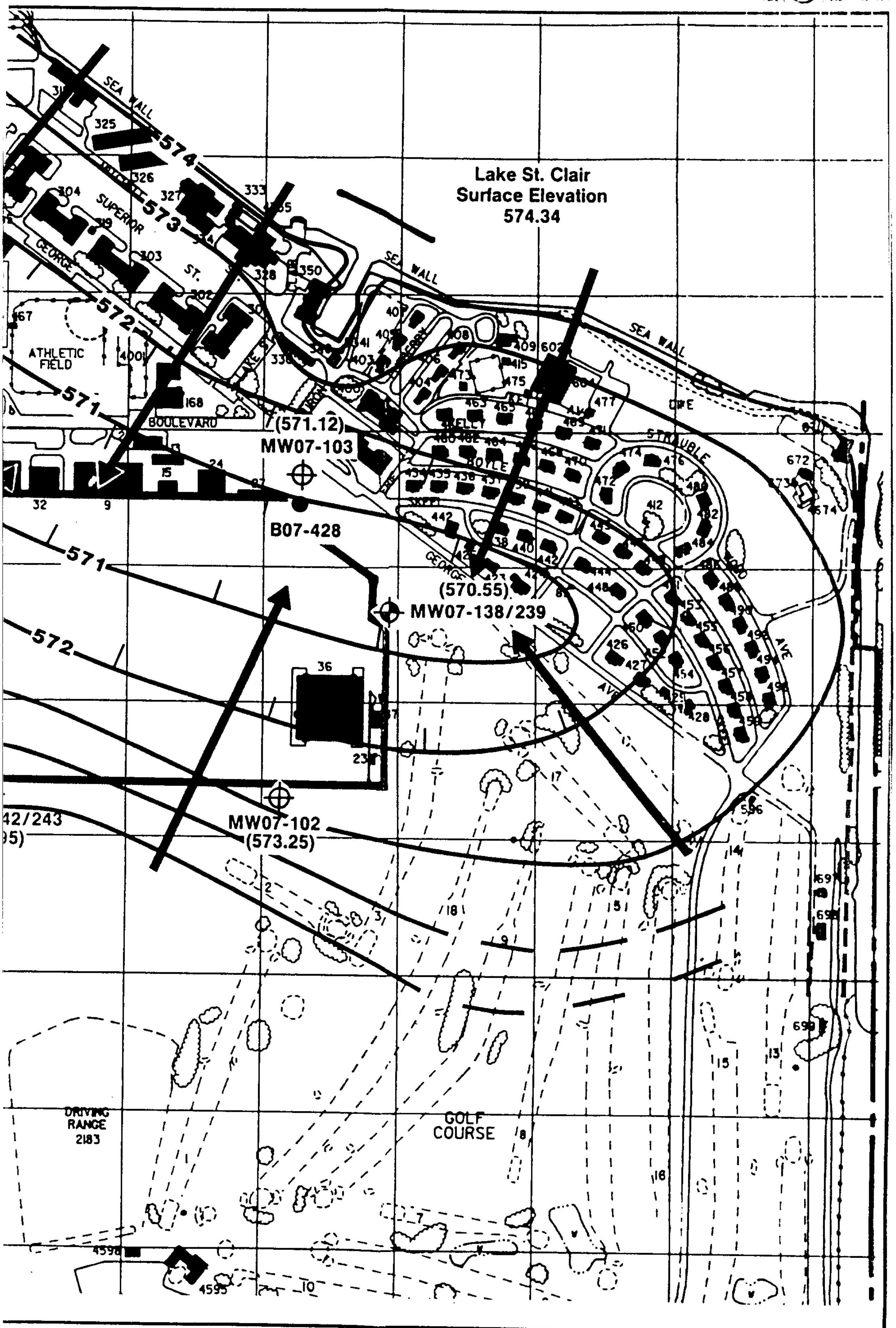
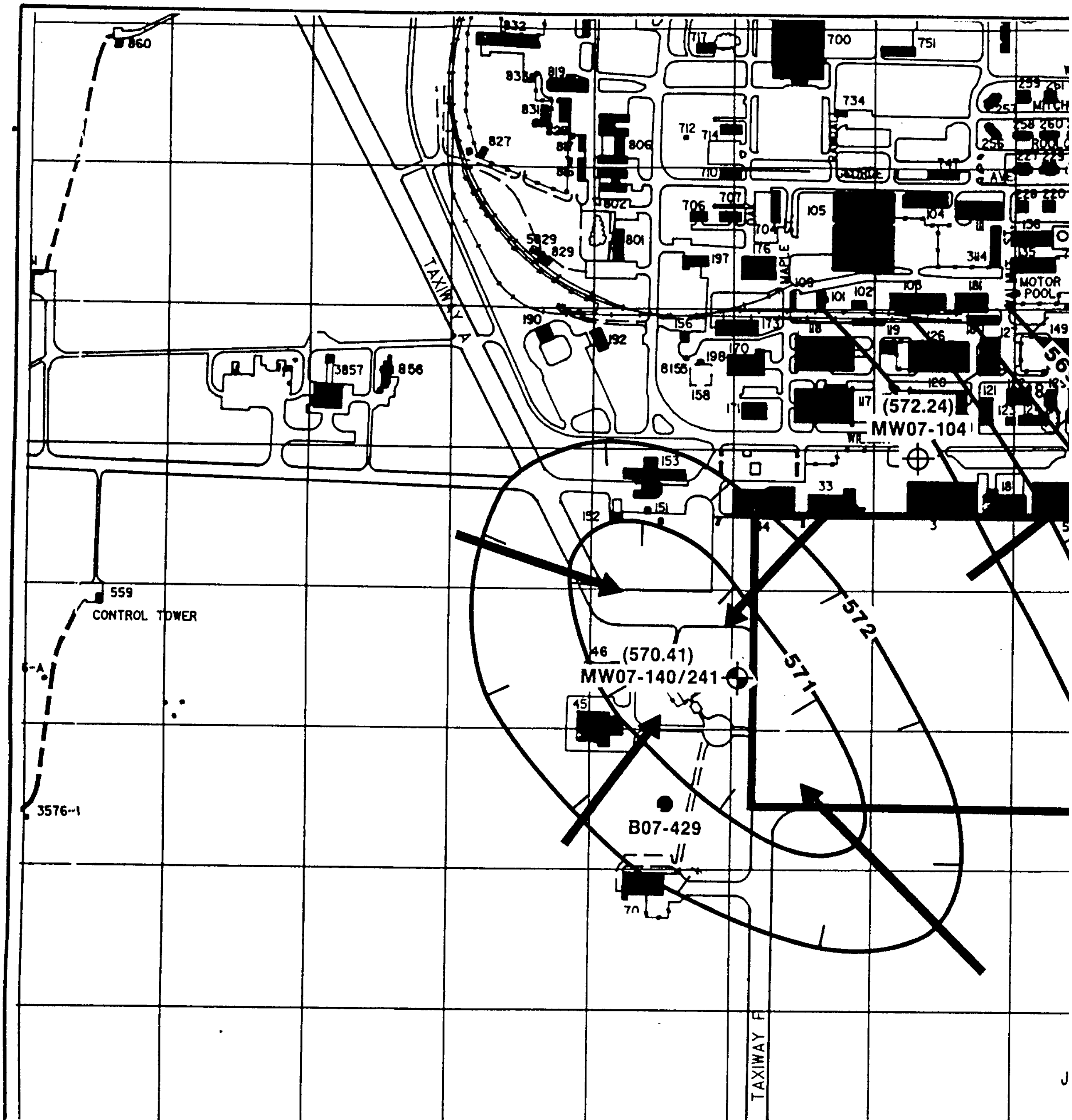


FIGURE 4-70 ERMP POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 21 MARCH 1988



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

N

Site Boundary

MW07-137/237 Nested Well Pair (Deep and Shallow)

MW07-102 Shallow Well

0 250 500 1000

Scale in Feet

B07-429 Soil Boring

571 Potentiometric Surface Contour

(570.57) Groundwater Elevation (Feet)

Groundwater Flow Direction

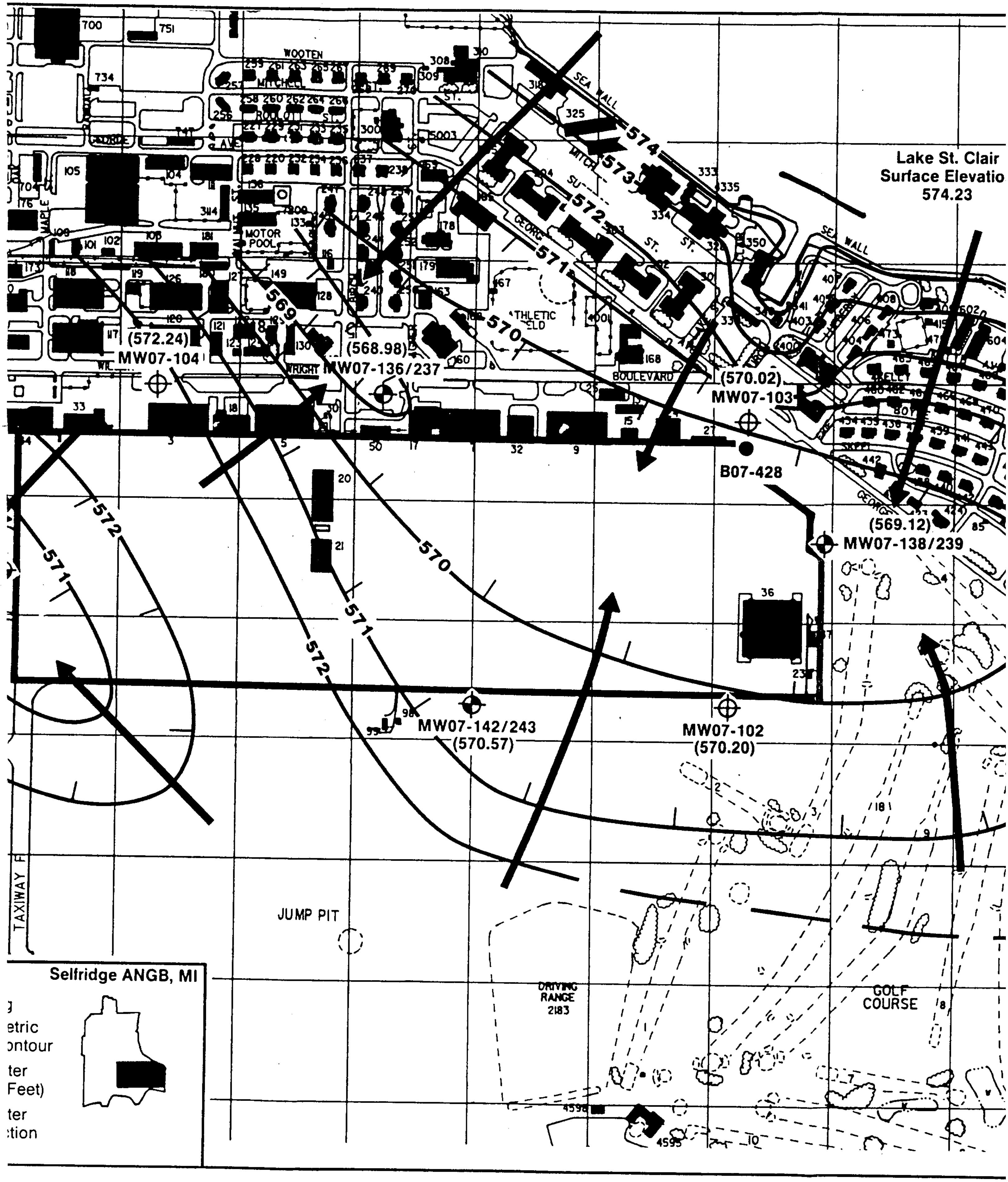


FIGURE 4-71 ERMP
MAP F
ON 1 A

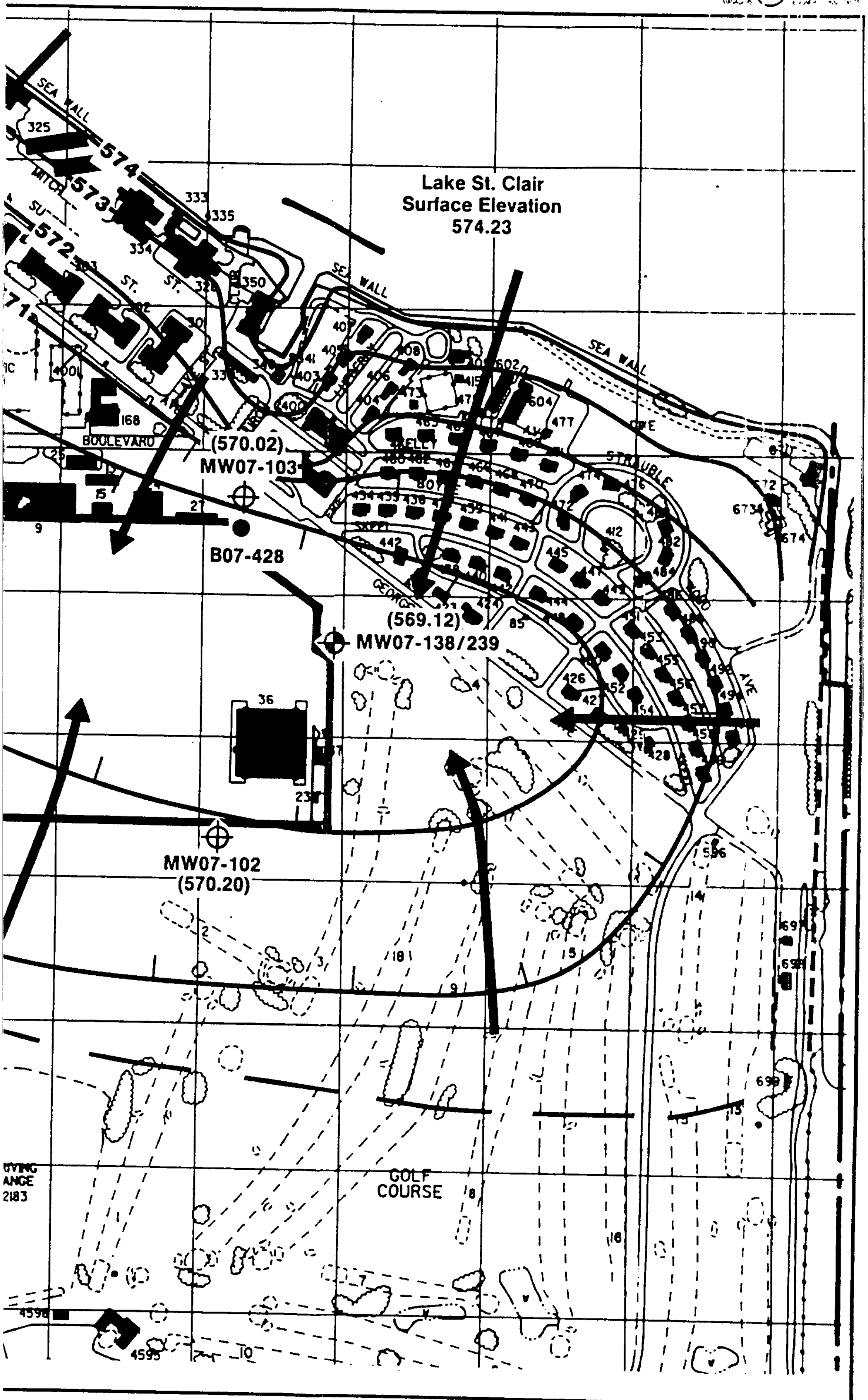
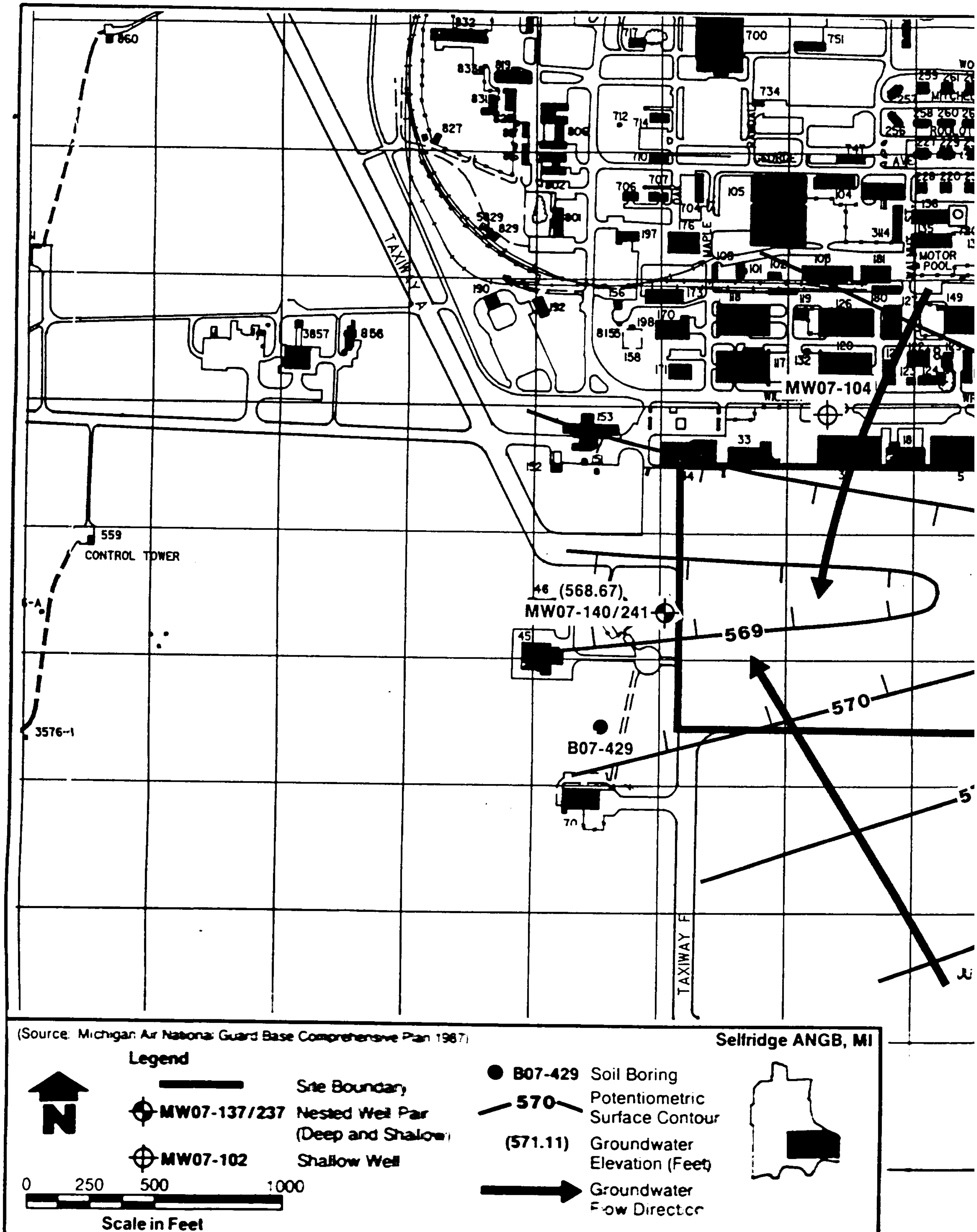


FIGURE 4-71 ERMP POTENTIOMETRIC SURFACE MAP FOR SHALLOW MONITOR WELLS ON 1 AUGUST 1988



MW07-104
(568.67)
MW07-140/241
569
570
B07-429
CONTROL TOWER
TAXIWAY A
TAXIWAY F
MOTOR POOL
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
Site Boundary
MW07-137/237 Nested Well Pair (Deep and Shallow)
MW07-102 Shallow Well
0 250 500 1000
Scale in Feet
B07-429 Soil Boring
570 Potentiometric Surface Contour
(571.11) Groundwater Elevation (Feet)
Groundwater Flow Direction

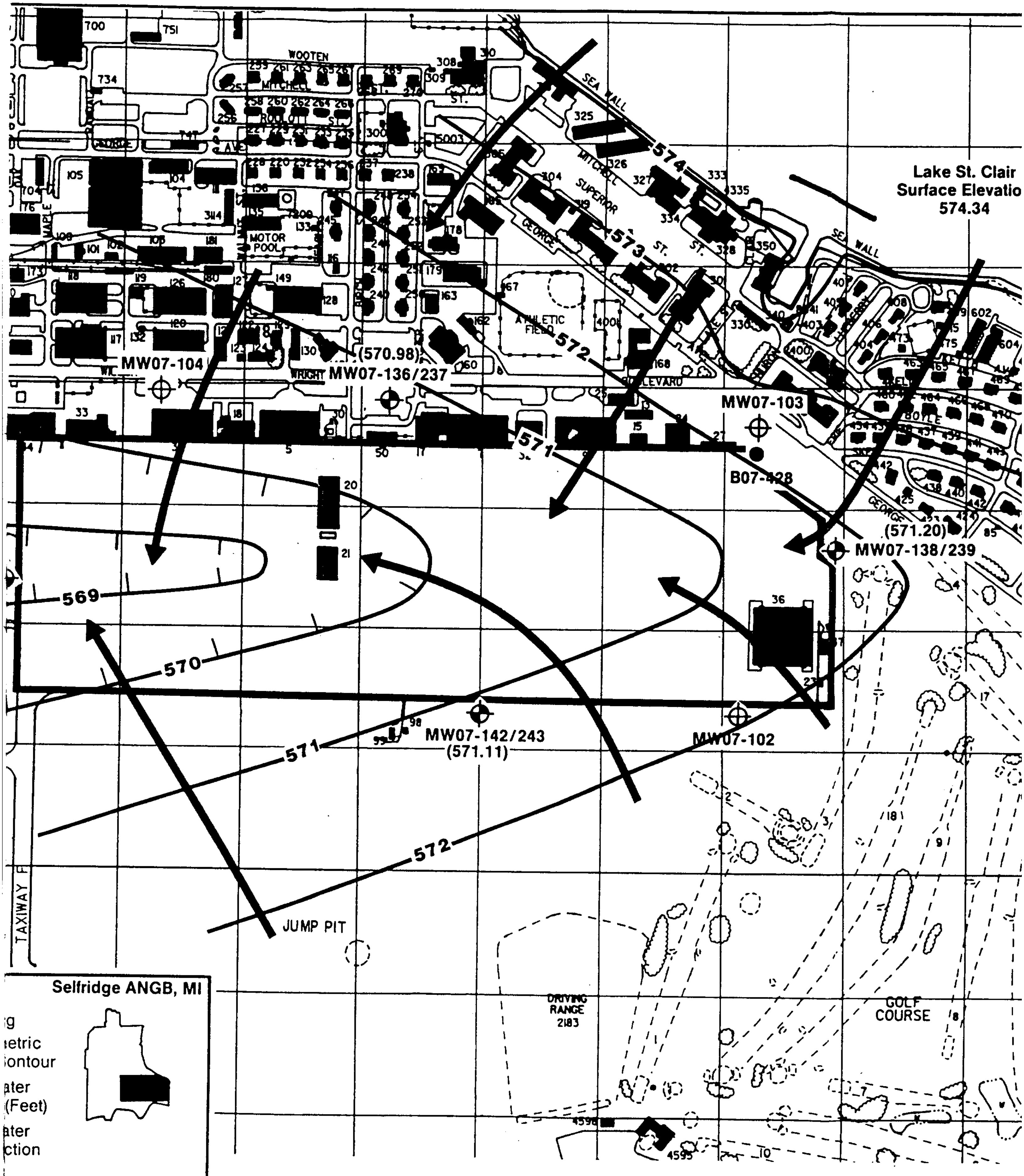


FIGURE 4-72 ERM
MAP
ON 2

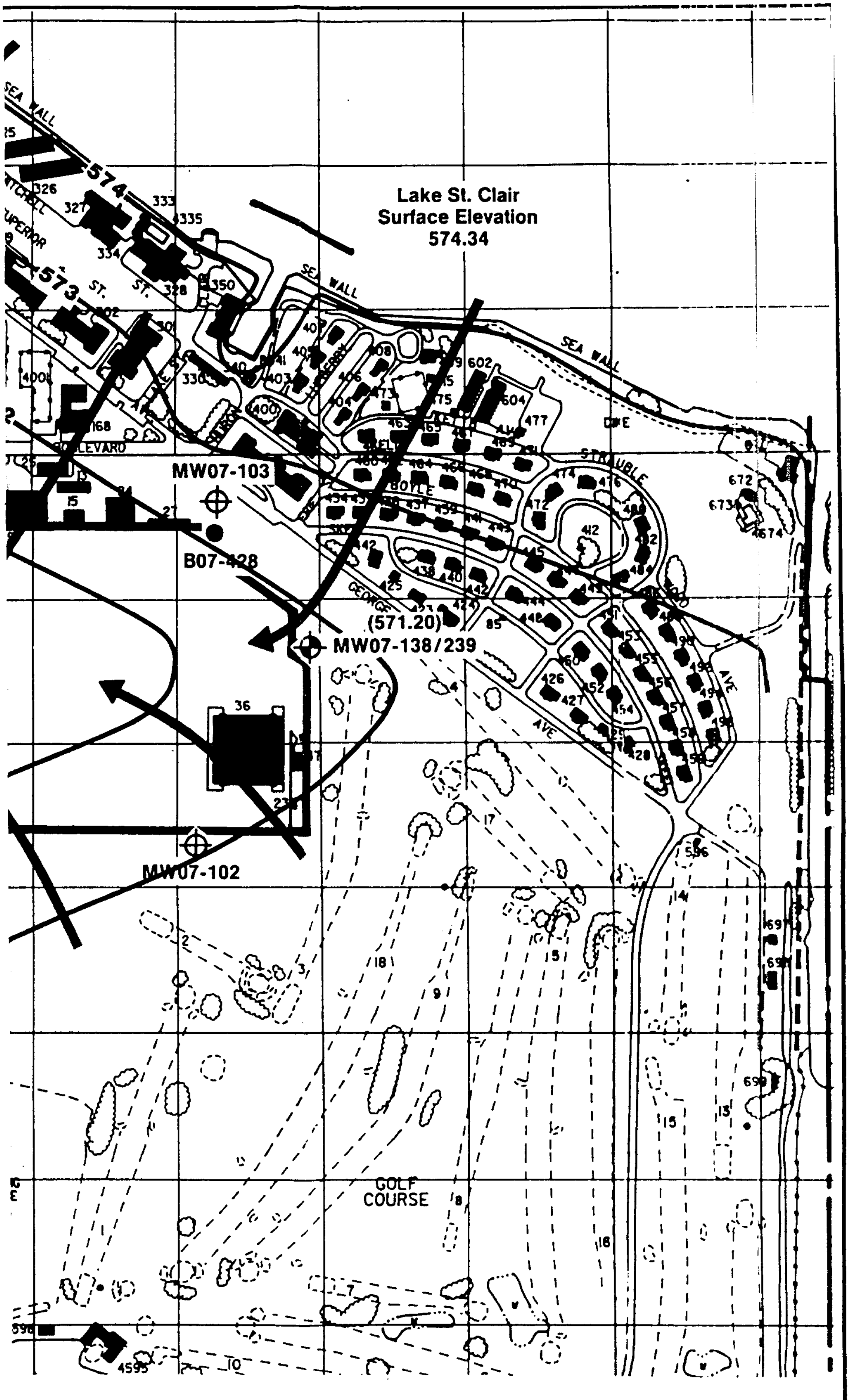
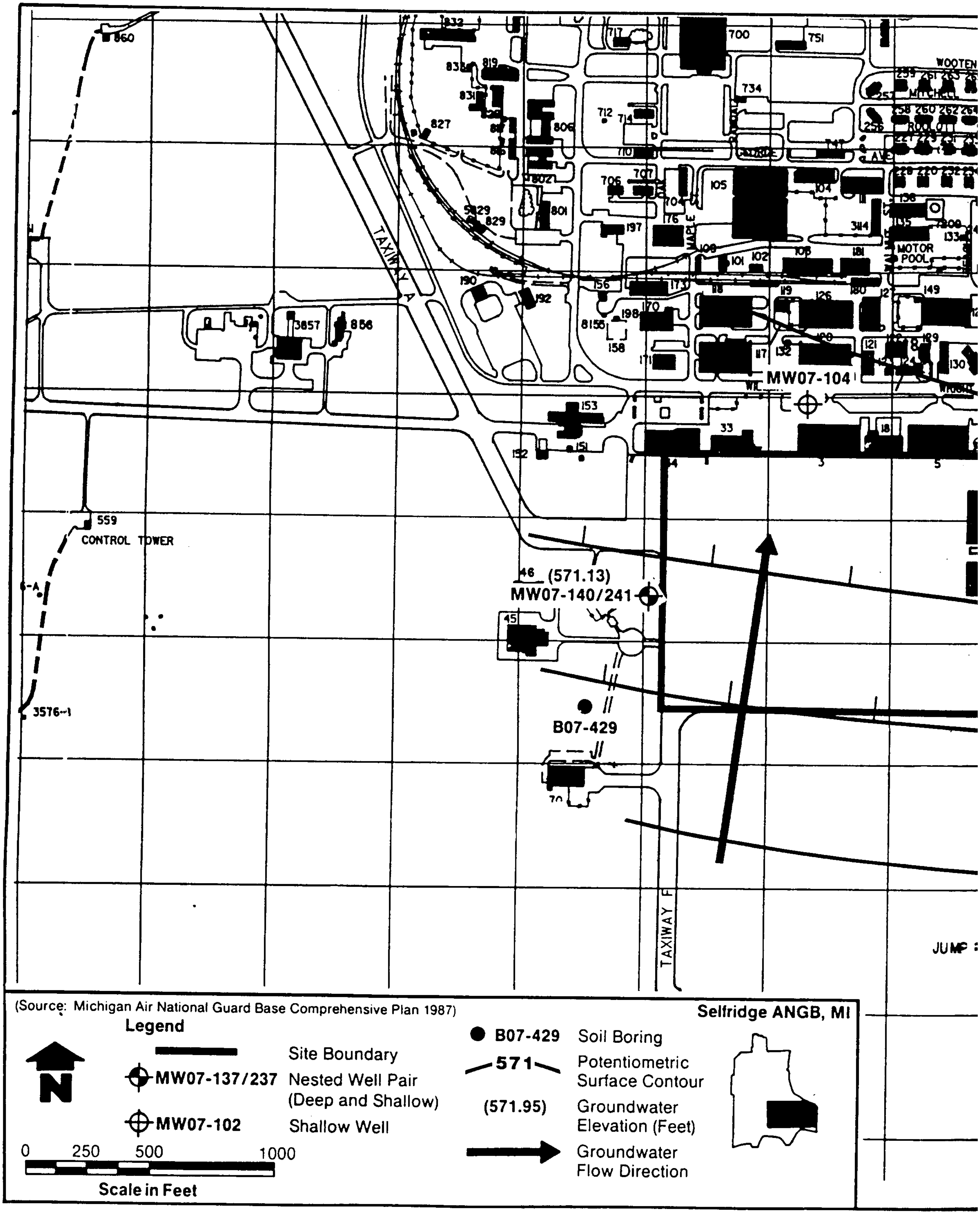


FIGURE 4-72 ERMP POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 21 MARCH 1988



860
CONTROL TOWER
559
3576-1
6-A
TAXIWAY A
TAXIWAY F
3857
856
832
838
819
831
827
806
802
801
829
712
714
710
706
707
704
717
700
751
734
105
104
314
176
197
108
101
102
103
181
190
192
156
173
118
119
126
180
198
170
8156
158
171
117
132
120
121
130
153
152
151
33
18
WOOTEN
MITCHELL
AVE
MOTOR POOL
MW07-104
(571.13)
MW07-140/241
45
46
B07-429
70
JUMP
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
N
Site Boundary
MW07-137/237 Nested Well Pair (Deep and Shallow)
MW07-102 Shallow Well
B07-429 Soil Boring
571 Potentiometric Surface Contour
(571.95) Groundwater Elevation (Feet)
Groundwater Flow Direction
0 250 500 1000
Scale in Feet

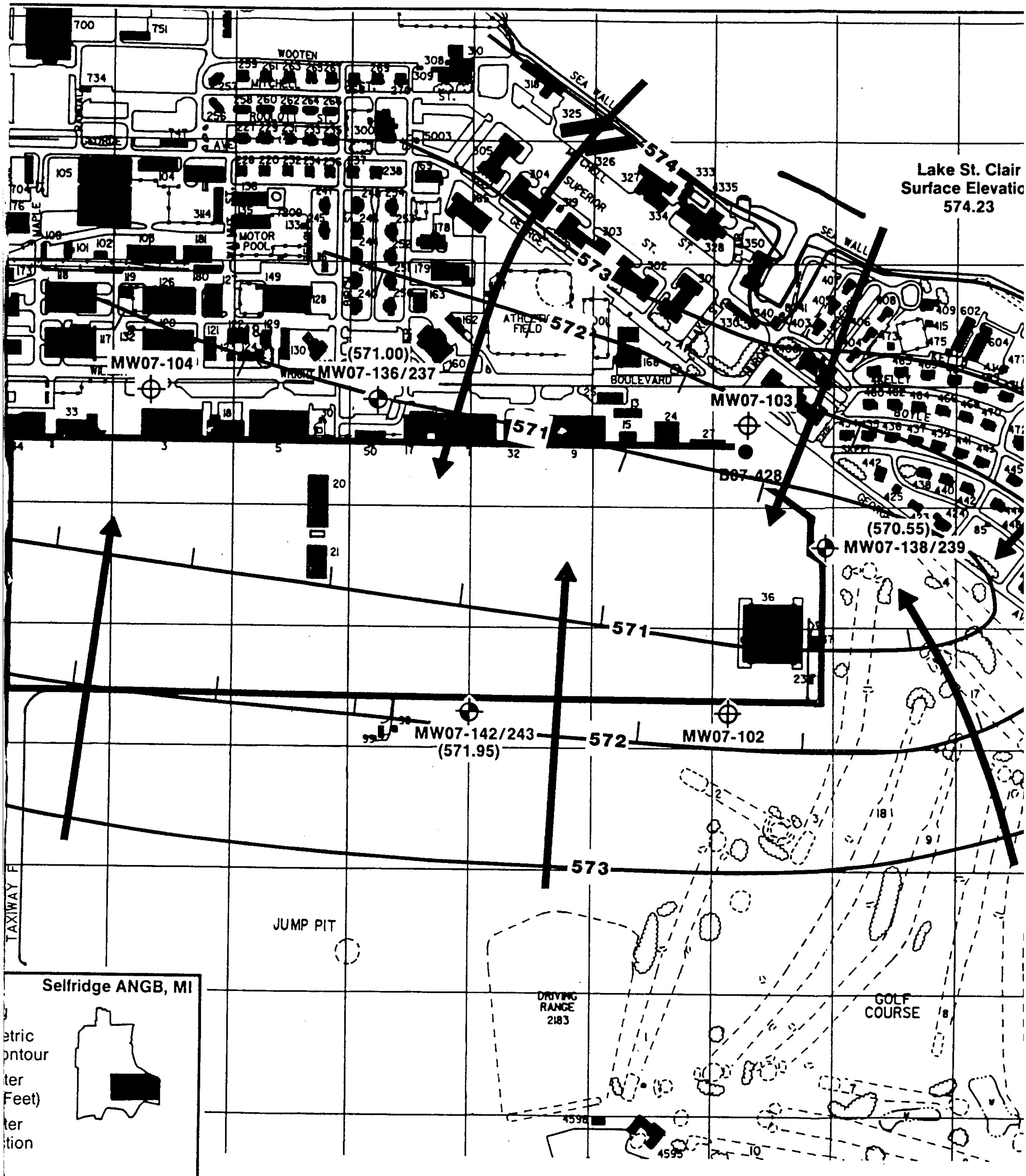


FIGURE 4-73 ERMP
MAP
ON 1

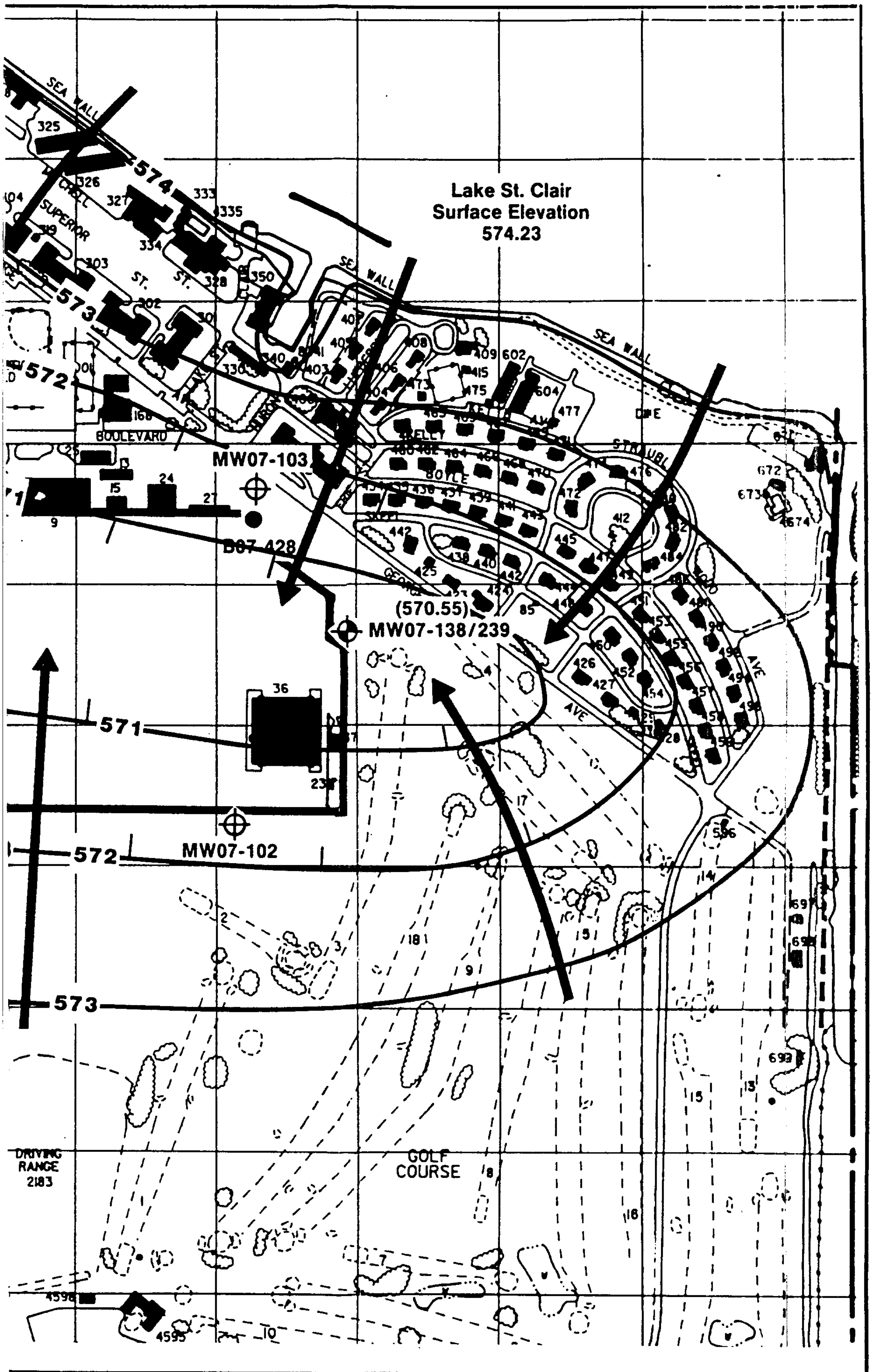


FIGURE 4-73 ERMP POTENTIOMETRIC SURFACE MAP FOR DEEP MONITOR WELLS ON 1 AUGUST 1988

porosity value of 0.15 percent, the groundwater flow velocity can be calculated. The groundwater flow velocity for shallow monitor wells on 21 March 1988 was 1.77 x 10^{-7} ft/sec (5.59 ft/year). The groundwater flow velocity for shallow monitor wells on 1 August 1988 was calculated to be 1.33 x 10^{-7} ft/sec (4.20 ft/year). The calculated groundwater flow velocity for deep monitor wells on 21 March and 1 August 1988 was 1.40 x 10^{-8} ft/sec (0.44 ft/year).

4.10.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- ERMP

ERMP serves as a staging and maintenance area for military airplanes. The concrete surface of the ERMP was designed to allow for rapid drainage of water, and stormwater catch basins located on and around the ERMP serve as collection points.

Stormwater runoff collected at catch basins flows through the stormwater drainage system for discharge. Figure 3-17 shows the locations of catch basins and sewer pipes at ERMP. Stormwater collected by the stormwater drainage system is discharged by two different pump lift stations. A portion of the stormwater is discharged into the Clinton River and the remainder into Lake St. Clair. The Lake St. Clair pump lift station is located along the shore of Lake St. Clair north of the eastern end of ERMP.

4.10.1.5 Direct Contact with Contaminated Media -- ERMP

Primarily, military and base maintenance personnel are allowed access to ERMP. These workers are the most likely to come in direct contact with any contaminants at the site. However, no provisions are made to physically restrict other persons from the site. Visitors to the base could also gain access to the site; however, ERMP is patrolled for security reasons to help prevent unauthorized access to the area.

4.10.1.6 Summary of Migration Pathways -- ERMP

Base personnel working at ERMP may come in contact with contaminants in the soil. This could occur due to trenching activity during the installation or repair of utilities. Ground maintenance workers could also come in contact with contaminants on the ground surface or in surface water ponded on the site during performance of their jobs at ERMP.

Persons and wildlife using and living within the Clinton River or Lake St. Clair could come in contact with contaminants discharged by the pump lift stations. Based upon potentiometric maps, groundwater from ERMP is intercepted by the stormwater drainage system and discharged to these water bodies. This could serve as a pathway for contaminants at ERMP to be transported from the site.

4.10.2 Contamination Profile -- ERMP

4.10.2.1 Chemical Results for Soil -- ERMP

One duplicate and seven investigative soil samples collected from ERMP were analyzed for chemical contaminants during the IRP Stage 2 investigation. The seven soil samples were taken from soil borings 07-428 and 07-429. The borings were located to the northeast and southwest of ERMP, near catch basins leading to major junctions of the stormwater drainage system. A large portion of stormwater runoff from ERMP is transported through these junctions.

The soil borings were drilled and the soils sampled on 10 January 1988. The soils were sent to WESTON/Gulf Coast Laboratories and were analyzed for petroleum hydrocarbons, volatile organics, and soil moisture content. One investigative soil sample taken from 9 to 10 feet BLS in soil boring 07-428 was analyzed for EP toxicity only. No holding times were exceeded for these samples. The surrogate recoveries ranged from 88 to 109 percent, and matrix spike recoveries ranged from 100 to 119 percent for the volatile organic analyses, which is within acceptable limits. At least one of the common laboratory and method contaminants that occurred in the quality control blanks was detected in the seven soil samples. These are methylene chloride (0.002 to 0.003 mg/kg) and acetone (0.002 to 0.046 mg/kg). None of these values exceed five times the threshold values for the lab contaminant as determined by the corresponding blanks for these compounds. They are, therefore, not considered to be contaminants of the soil at ERMP.

Table 4-63 lists the valid analytes and concentrations detected in soil samples collected at ERMP. Carbon disulfide (0.002 to 0.032 mg/kg) was detected in soil samples 07-428-B001 and 07-429-B003. Soil from 10 to 15 feet BLS in boring 07-429 also contained carbon disulfide (0.017 mg/kg). Sample 07-428-B001 contained 1,1,1-trichloroethane (<0.002 mg/kg). Although carbon disulfide and 1,1,1-trichloroethane were not detected in any of the blanks, they are common laboratory contaminants, and their detection only at trace concentrations suggests that they may not be site contaminants. Petroleum hydrocarbons (99 mg/kg) were detected in soil boring 07-428 at 20 to 24.8 feet BLS and at 79 mg/kg in soil boring 07-429 at 25 to 30 feet BLS.

4.10.2.2 Chemical Results for Groundwater -- ERMP

One duplicate and 11 investigative groundwater samples were retained for analyses of chemical contaminants during the IRP Stage 2 investigation. They were collected from monitor wells placed around the perimeter of ERMP. The groundwater samples were collected between 18 April and 22 April 1988.

TABLE 4-63

VALID ANALYTES DETECTED IN SOIL AT ERMP,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE #	07-428-B001			07-428-B002			07-428-B102			07-428-B003			07-429-B001			07-429-B002		
	RFW #	121471			121472			121473			121474			121476			121477		
	SAMPLE DATE	10-JAN-88			10-JAN-88			10-JAN-88			10-JAN-88			10-JAN-88			10-JAN-88		
	DEPTH	5-9 FEET			10-15 FEET			10-15 FEET			20-24.8 FEET			5-10 FEET			10-15 FEET		
	% MOISTURE	22.5			30.9			33.5			37.8			24.6			27.0		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
CARBON DISULFIDE	SW5030/SW8240	0.006	0.002	<	0.007		ND	0.008		ND	0.008		ND	0.007		ND	0.007	0.017	=
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.006	0.002	<	0.007		ND	0.008		ND	0.008		ND	0.007		ND	0.007		ND
PETROLEUM HYDROCARBONS	SW3550/E418.1	63.6		ND	71.3		ND	75.2		ND	79.6	99	=	66		ND	67.8		ND

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

	SAMPLE #	07-429-B003			07-429-B003														
	RFW #	121478			121478 SPIKE DUP														
	SAMPLE DATE	10-JAN-88			10-JAN-88														
	DEPTH	25-30 FEET			25-30 FEET														
	% MOISTURE	32.7			32.7														
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (ug/L)	QL
CARBON DISULFIDE	SW5030/SW8240	0.007	0.032	=															
1,1,1-TRICHLOROETHANE	SW5030/SW8240	0.007		ND															
PETROLEUM HYDROCARBONS	SW3550/E418.1	73.2		ND	73.2	79	=												

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

The groundwater samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, petroleum hydrocarbons, common anions, alkalinity, and TDS, except for samples 07-138-M001 and 07-239-M001. Holding times were exceeded for common anions (chloride, phosphate, and sulfate) analyses of samples 07-102-M001, 07-237-M001, 07-140-M001, 07-142-M001, and 07-243-M001 and for petroleum hydrocarbons analyses of samples 07-239-M001 and 07-241-M001. Monitor wells 07-102, 07-237, 07-140, 07-142, and 07-243 were resampled for common anions on 21 June 1988. All the monitor wells were resampled on 4 through 6 August 1988 for nitrate/nitrate and TDS (except monitor wells 07-138 and 07-239 for TDS). WESTON/Gulf Coast Laboratories analyzed the resampled groundwater. No holding times were exceeded.

Surrogate recoveries for purgeable halocarbons analyses ranged from 62 percent to 86 percent. All surrogate recoveries and detection limits were within quality control limits.

Table 4-64 lists the valid analytes and concentrations detected in the groundwater samples collected at ERMP. Purgeable halocarbons analyses detected ethylbenzene in the investigative and duplicate samples retained from monitor well 07-136 at concentrations of 4 to 6 ug/L. No other purgeable halocarbons were detected. Petroleum hydrocarbons were detected in samples from monitor wells 07-102, 07-138, 07-140, 07-142, 07-237, and 07-243 in concentrations of 1.1 to 2.0 mg/L. Chloride was detected in background concentrations (2.5 to 129 mg/L) in each sample except 07-102-M021 (553 mg/L) and 07-241-M001 (500 mg/L). Those two concentrations are above the secondary drinking water standard of 250 mg/L. Analyses for sulfate detected only background concentrations (26 to 83.9 mg/L). Samples collected at monitor well 07-237 (07-237-M001) contained a high concentration of alkalinity (5,700 mg/L) and TDS (13,000 mg/L). This was the highest concentration of the parameter measured during the IRP Stage 2 investigation of Selfridge ANGB. All other concentrations detected of alkalinity (120 to 590 mg/L) and TDS (350 to 1,200 mg/L) were within background ranges. Nitrate/nitrite was detected in low concentrations (0.2 to 0.3 mg/L) in groundwater samples 07-140-M001 and 07-243-M001.

4.10.2.3 Chemical Results for Surface Water -- ERMP

Four surface water sampling stations were established in the stormwater drainage system at ERMP. They were placed at primary sewer pipe junctions to monitor all of the surface water that flowed from ERMP into the stormwater drainage system. Four investigative surface water samples were collected on 20 April 1988 after an extended dry period, and four investigative surface water samples were collected on 10 May 1988 after a significant wet event.

The surface water samples were sent to WESTON/Gulf Coast Laboratories for analyses of purgeable aromatics, petroleum

TABLE 4-64

VALID ANALYTES DETECTED IN GROUNDWATER AT ERMP,
IRP STAGE 2, SELFRIDGE ANGB, MI

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE # RFW # SAMPLE DATE		07-102-M001 129020 22-APR-88			07-103-M001 128944 20-APR-88			07-104-M001 128945 21-APR-88			07-136-M001 128946 21-APR-88			07-136-M101 128947 21-APR-88			07-138-M001 128516 18-APR-88		
ETHYLBENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2	5 (4)	=	2	6 (ND)	=	2		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.02	1.3	=	1.00		NV	1.04		ND	1.08		NV	1.05		NV	1.12	2	*
ALKALINITY	A403	mg/L	10	470	=	10	590	=	10	360	*	10	410	=	10	420	*	10	580	*
FLUORIDE	E340.2	mg/L	0.1	0.6	*	0.1	0.3	=	0.1		NV	0.1		NV	0.1		NV	0.1	0.2	*
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT	10		HT	10	740	*
	SAMPLE # RFW # SAMPLE DATE		07-102-M021 8806-761-005 21-JUN-88			07-103-M001 8804-183-036 20-APR-88			07-104-M001 8804-183-037 21-APR-88			07-136-M001 8804-183-038 21-APR-88			07-136-M101 8804-183-039 21-APR-88			07-138-M001 8804-183-001 18-APR-88		
CHLORIDE	A429	mg/L	25	553	*	25	129	*	2.5	32.3	*	25	105	*	25	94.6	*	2.5	52.2	*
SULFATE	A429	mg/L	2.5	26	*	2.5	22.5	*	2.5	20.6	=	2.5	2.7	*	2.5		ND	25	83.9	*
	SAMPLE # RFW # SAMPLE DATE		07-102-M001 136994 05-AUG-88			07-103-M001 136991 05-AUG-88			07-104-M001 137021 04-AUG-88			07-136-M001 137023 04-AUG-88			07-102-M101 136995 05-AUG-88			07-138-M001 137018 04-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1		ND	0.1		ND	0.1		ND	0.1		ND	0.1		ND	0.1		ND
	SAMPLE # RFW # SAMPLE DATE		07-102-M021 136993 05-AUG-88			07-103-M021 136992 05-AUG-88			07-104-M021 137022 04-AUG-88			07-136-M021 137024 04-AUG-88			07-241-M121 137233 06-AUG-88					
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	550	*	10	1200	*	10	640	*	10	820	*						
PETROLEUM HYDROCARBONS	E418.1	mg/L													1.04	2.1	*			

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIMES EXCEEDED; ANALYSIS NOT VALID
* - CONCENTRATION SHOWN IS VALID

TABLE 4-64

(CONTINUED)

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE # / RFW # / SAMPLE DATE		07-140-M001 / 129022 / 22-APR-88			07-142-M001 / 129023 / 22-APR-88			07-237-M001 / 129024 / 22-APR-88			07-239-M001 / 128518 / 18-APR-88			07-241-M001 / 128519 / 18-APR-88			07-243-M001 / 129025 / 22-APR-88		
ETHYLBENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND	2		ND	2		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.01	1.6	=	1.04	1.6	=	1.08	1.4	=	1.08		HT	1.08		HT	1.04	1.1	=
ALKALINITY	A403	mg/L	10	330	=	10	480	=	10	5700	=	10	210	=	10	130	=	10	320	=
FLUORIDE	E340.2	mg/L	0.1	0.2	=	0.1	0.2	=	0.1	0.8	=	0.1		NV	0.1		NV	0.1	0.8	=
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10	350	=	10		HT	10		HT
	SAMPLE # / RFW # / SAMPLE DATE		07-140-M021 / 8806-761-002 / 21-JUN-88			07-142-M021 / 8806-761-001 / 21-JUN-88			07-237-M021 / 8806-761-006 / 21-JUN-88			07-239-M001 / 8804-183-002 / 18-APR-88			07-241-M001 / 8804-183-003 / 18-APR-88			07-243-M021 / 8806-761-004 / 21-JUN-88		
CHLORIDE	A429	mg/L	25	62	=	2.5	2.5	=	62.5	63	=	25	103	=	25	500	=	50	126	=
SULFATE	A429	mg/L	25	63	=	25	60	=	2.5		ND	2.5		ND	2.5		ND	2.5		ND
	SAMPLE # / RFW # / SAMPLE DATE		07-140-M001 / 137007 / 05-AUG-88			07-142-M001 / 137025 / 04-AUG-88			07-237-M001 / 137016 / 04-AUG-88			07-239-M001 / 137020 / 04-AUG-88			07-241-M001 / 137231 / 06-AUG-88			07-243-M001 / 136998 / 04-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1	0.2	=	0.1		ND	0.1		ND	0.1		ND	0.1		ND	0.2	0.3	=
	SAMPLE # / RFW # / SAMPLE DATE		07-140-M021 / 137008 / 05-AUG-88			07-142-M021 / 137026 / 04-AUG-88			07-237-M021 / 137017 / 04-AUG-88			07-239-M021 / 137027 / 04-AUG-88			07-241-M021 / 137232 / 06-AUG-88			07-243-M021 / 136997 / 04-AUG-88		
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	700	=	10	720	=	10	13000	=				10	1200	=	10	630	=
PETROLEUM HYDROCARBONS	E418.1	mg/L										1.02		ND	1.05		NV			

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIMES EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

hydrocarbons, common anions, alkalinity, and TDS. Holding times were exceeded for all TDS analyses and all but one petroleum hydrocarbons analysis (07-521-W001). The same surface water stations were resampled on 3 August (wet event) and 8 August 1988 (dry event) for these parameters and for nitrate/nitrite. No holding times were exceeded for these resampled analytes.

Surrogate recoveries for purgeable aromatics ranged from 56 to 138 percent. All detection limits and surrogate recoveries were within quality control limits.

Table 4-65 lists the valid analytes and concentrations detected in surface water collected at ERMP. Surface water sample 07-521-W002 contained relatively high concentrations of benzene (11 to 35 ug/L), toluene (140 to 178 ug/L), ethylbenzene (20 ug/L), and xylenes (13 to 38 ug/L). Surface water sample 07-523-W002 (wet event) contained benzene (2 to 4 ug/L) and toluene (3 to 4 ug/L). No corresponding concentrations were found in surface water samples collected at these stations for the dry event. Petroleum hydrocarbons were detected at station 07-521 (4.6 ug/L - dry event; 1.6 ug/L - wet event). Sample 07-522-W002 (wet event) also contained petroleum hydrocarbons (1.7 ug/L). Chloride (3 to 160 mg/L), sulfate (16.7 to 54.4 mg/L), alkalinity (70 to 350 mg/L), and TDS (100 to 690 mg/L) all occurred within background ranges, as defined by statistical analysis, for all surface water samples (dry and wet event). Nitrate/nitrite occurred in concentrations from 1.1 to 3.2 mg/L in all surface water samples collected (dry and wet event).

4.10.3 Extent of Contamination -- ERMP

During the Phase II Stage 1 investigation 12 soil samples were retained from 4 soil borings drilled at 4 corners of the ERMP for analyses of oil and grease and volatile organics. The samples were retained from the 7.5-, 15.5-, and 25.0-foot levels of monitor well borings 07-101, 07-102, 07-103, and 07-104. The analyses detected chloroform (<2.0 to 490 mg/kg), methylene chloride (<3.0 to 1,800 mg/kg), toluene (<2.0 to 60 mg/kg), 1,1,1-trichloroethane (<2.0 to 2,100 mg/kg), 1,1,2-trichloroethane (<2.0 to 1,000 mg/kg), trichloroethene (107 to 6,800 mg/kg), trichlorofluoromethane, and oil and grease (69 to 229 mg/kg). Every soil sample analyzed contained trichloroethene, and the highest concentrations of the contaminants were predominantly in the 15.5- and 25-foot levels.

The IRP Stage 2 investigation sampled soils from two borings located near catch basins at two major junctions of the stormwater drainage system. The analyses detected petroleum hydrocarbons (79 to 99 mg/kg) in both soil borings at the 20- to 30-foot level. Trace quantities of the solvents carbon disulfide and 1,1,1-trichloroethane (<0.002 to 0.032 mg/kg) were detected at all levels. Trichloroethene was not detected in these soil

TABLE 4-65

VALID ANALYTES DETECTED IN DRY-EVENT SURFACE WATER AT ERMP,
IRP STAGE 2, SELFRIDGE ANGB, MI

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE # RFW # SAMPLE DATE		07-521-W001 128950 20-APR-88			07-522-W001 128951 20-APR-88			07-523-W001 128952 20-APR-88			07-524-W001 128953 20-APR-88					
BENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND			
TOLUENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND			
ETHYLBENZENE	SW5030/SW8020	ug/L	2		ND	2		ND	2		ND	2		ND			
XYLENES	SW5030/SW8020	ug/L	5		ND	5		ND	5		ND	5		ND			
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.10		HT	1.03		HT	1.12		HT	1.03		HT			
ALKALINITY	A403	mg/L	10	240	=	10	290	=	10	350	=	10	70	=			
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV			
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT			
	SAMPLE # RFW # SAMPLE DATE		07-521-W001 8804-183-042 20-APR-88			07-522-W001 8804-183-043 20-APR-88			07-523-W001 8804-183-044 20-APR-88			07-524-W001 8804-183-045 20-APR-88					
CHLORIDE	A429	mg/L	25	45	=	25	90.4	=	25	56.6	=	2.5		ND			
SULFATE	A429	mg/L	2.5	27.8	=	2.5	16.7	=	2.5	30.1	=	2.5		ND			
	SAMPLE # RFW # SAMPLE DATE		07-521-W001 137330 08-AUG-88			07-522-W001 137328 08-AUG-88			07-523-W001 137336 08-AUG-88			07-524-W001 137342 08-AUG-88			07-523-W101 137337 08-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1	1.2	=	0.1	1.1	=	0.1	1.9	=	0.1	1.8	=	0.1	1.8	=
	SAMPLE # RFW # SAMPLE DATE		07-521-W021 137331 08-AUG-88			07-522-W021 137329 08-AUG-88			07-523-W021 137341 08-AUG-88			07-524-W021 137343 08-AUG-88					
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	690	=	10	500	=	10	530	=	10	100	=			
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00	4.6	=	1.06		ND	1.02		ND	1.04		ND			

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NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
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HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-65

(CONTINUED)

ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
	SAMPLE #		07-521-W002			07-522-W002			07-523-W002			07-524-W002		
	RFW #		130208			130209			130210			130211		
	SAMPLE DATE		10-MAY-88			10-MAY-88			10-MAY-88			10-MAY-88		
BENZENE	SW5030/SW8020	ug/L	2	11 (35)	=	2		ND	2	4 (2)	=	2		ND
TOLUENE	SW5030/SW8020	ug/L	2	178 (140)	=	2		ND	2	4 (3)	=	2		ND
ETHYLBENZENE	SW5030/SW8020	ug/L	2	20 (20)	=	2		ND	2		ND	2		ND
XYLENES	SW5030/SW8020	ug/L	5	38 (13)	=	5		ND	5		ND	5		ND
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.02		HT	1.02		HT	1.02		HT	1.02		HT
ALKALINITY	A403	mg/L	10	240	=	10	290	=	10	350	=	10	70	=
FLUORIDE	E340.2	mg/L	0.1		NV	0.1		NV	0.1		NV	0.1		NV
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT
	SAMPLE #		07-521-W002			07-522-W002			07-523-W002			07-524-W002		
	RFW #		8805-386-024			8805-386-025			8805-386-028			8805-386-031		
	SAMPLE DATE		10-MAY-88			10-MAY-88			10-MAY-88			10-MAY-88		
CHLORIDE	A429	mg/L	62.5	138	=	62.5	160	=	2.5	43.2	=	2.5	3	=
SULFATE	A429	mg/L	2.5	54.4	=	2.5	43	=	2.5	51.2	=	2.5	38.9	=
	SAMPLE #		07-521-W002			07-522-W002			07-523-W002			07-524-W002		
	RFW #		136841			136843			136810			136816		
	SAMPLE DATE		03-AUG-88			03-AUG-88			03-AUG-88			03-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1	1.2	=	0.1	1.4	=	1.0	3.2	=	0.1	1.6	=
	SAMPLE #		07-521-W022			07-522-W022			07-523-W002			07-524-W002		
	RFW #		136842			136844			136811			136817		
	SAMPLE DATE		03-AUG-88			03-AUG-88			03-AUG-88			03-AUG-88		
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	570	=	10	460	=	10	440	=	10	110	=
PETROLEUM HYDROCARBONS	E418.1	mg/L	1.00	1.6	=	1.01	1.7	=	1.23		NV	1.02		NV

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samples. The presence of trichloroethene in all the soils analyzed during the Phase II Stage 1 investigation and the total lack of it in the soils analyzed during the IRP Stage 2 investigation may signify a sampling, drilling, or laboratory problem during the Phase II Stage 1 investigation or a difference in location of the Stage 2 soil borings as compared to those for the Phase II Stage 1 borings.

From the soil analyses of the two investigations it can be inferred that operations at ERMP have resulted in fuel and degreasing solvent contamination. The Phase I records search stated that a spill of 6,000 gallons had occurred at ERMP, although the date and exact location were not specified. Based upon calculations presented in Subsection 4.2, spills that are considerably smaller than 6,000 gallons could saturate the upper layers of soil and migrate to the groundwater. Also, slow leakages may migrate down macropores without saturating the upper layers of soil and reach the groundwater. From the sampling and analyses it is apparent that some migration to the water table has occurred, as the soils surrounding ERMP appear to contain petroleum hydrocarbons and chlorinated solvents to a depth of 30 feet. Maximum levels of contamination are in the 15- to 30-foot level. The soils next to major catch basins of the stormwater drainage system have collected some of these contaminants, but the highest levels are closest to the suspected areas of frequent fuel spillage, such as the refueling stations and the maintenance buildings.

Groundwater was sampled from four monitor wells (07-101 through 07-104) during the Phase II Stage 1 investigation and were analyzed for volatile organics, TOC, and petroleum hydrocarbons. Petroleum hydrocarbons were detected in all of the wells (0.6 to 9.2 mg/L), and trichloroethene (4.9 to 9.0 ug/L) was detected in monitor wells 07-101 and 07-102. The IRP Stage 2 investigation sampled 11 wells for groundwater, including 8 newly constructed wells and 3 Phase II Stage 1 wells. Monitor well 07-101 had been destroyed before the IRP Stage 2 investigation commenced and, therefore, could not be resampled. None of the wells sampled during the IRP Stage 2 investigation contained trichloroethene. Ethylbenzene (5 ug/L) was detected in monitor well 07-136. The presence of petroleum hydrocarbons (1.1 to 2 mg/L) in the groundwater around ERMP was confirmed in monitor wells 07-102, 07-237, 07-138, 07-140, 07-142, and 07-243, which are located around the perimeter of ERMP. This suggests the occurrence of multiple releases of petroleum hydrocarbons at ERMP from normal aircraft operations such as refueling. The presence of petroleum hydrocarbons in both the shallow and deep wells (07-104/243) near the fuel storage area on the southern side of ERMP also suggests fuel leakage in this area.

Several monitor wells had high indicator parameter values possibly unrelated to petroleum spills. Monitor well 07-237,

which contained groundwater artificially high in temperature due to a steam leak, also had high TDS (13,000 mg/L) and alkalinity (5,700 mg/L) concentrations. Chloride values above secondary drinking water levels were detected in monitor wells 07-241 (500 mg/L) and 07-102 (553 mg/L). These two monitor wells are located in areas of high personnel vehicular traffic on ERMP. Although salt is not used on the ramps for snow and ice removal, vehicular traffic may track salt from the service roads on the base to ERMP, resulting in elevated levels of the above contaminants in the groundwater.

Potentiometric groundwater maps of the area around ERMP show that the groundwater trough detected at TCLF extends to ERMP. The trough is due to groundwater infiltration (see Figures 4-70 and 4-71) into the stormwater drainage system, resulting in the local depression of the potentiometric surface. The axis of the trough parallels the shoreline of Lake St. Clair. The trough is better defined on the potentiometric maps for the shallow wells than on the potentiometric maps for the deep wells. Because of this trough, groundwater in the area moves toward ERMP at flow velocities of 5.59 to 4.20 ft/year (shallow monitor wells) and 0.44 ft/year (deep monitor wells). Contaminants in the groundwater would, therefore, migrate in the same direction, but at slower rates due to adsorption and desorption. Calculations made based upon the retardation equation (see Subsection 4.2) estimate that petroleum hydrocarbons and chlorinated solvents would migrate at the maximum rates of 1.36 to 1.85 ft/year (based upon porosity of 15 percent and an organic carbon content of 0.1 percent).

The primary method of transportation of contaminants from ERMP is via the surface stormwater drainage system. Surface waters were not sampled at ERMP during the Phase II Stage 1 investigation. The IRP Stage 2 investigation surface water sampling confirmed the presence of petroleum hydrocarbons in the stormwater sewers. Station 07-521 contained petroleum hydrocarbons (1.6 to 4.6 mg/L) during both the wet- and dry-event sampling. Station 07-522 also contained petroleum hydrocarbons (1.7 mg/L) during the wet event. Benzene (4 ug/L) and toluene (4 ug/L), which are major constituents of JP-4, were detected in the wet-event sample taken from station 07-523. The effectiveness of dilution and mixing are apparent when noting that station 07-521, which contained petroleum hydrocarbons, is upgradient of station 07-523, which did not contain petroleum hydrocarbons in either wet or dry sampling event. During the wet-event sampling a strong solvent odor was noted at station 07-521. BTX compounds and ethylbenzene were detected in the surface water sample from this location in concentrations of 11 to 178 ug/L. The improper disposal of solvents in one of the maintenance buildings is suspected for the presence of these compounds in this sample. It would appear that the stormwater drainage system at ERMP may be contaminated by both improper disposal of solvent and past fuel leaks or spills.

No analyte concentrations exceeding applicable standards were detected in soil collected at ERMP. TDS concentrations in all groundwater samples collected exceeded the standard for potential international chemical-specific ARARs (see Table 4-66). Concentrations ranged between 350 and 1,300 mg/L. Benzene was detected at concentration exceeding several standards (see Table 4-67) in wet-event surface water samples 07-521-W002 and 07-523-W002. TDS concentrations in three wet- and dry-event surface water samples from the same sampling locations exceeded the standard for potential international chemical-specifc ARARs (see Table 4-67). Concentrations ranged from 440 to 690 mg/L.

4.10.4 Qualitative Risk Assessment -- ERMP

Sampling data from ERMP indicate limited contamination of subsurface soils, groundwater, and surface water. Eleven individual chemical species were detected in site media, and six of these were identified as indicator chemicals using the EPA indicator chemical selection process. These contaminants of concern are listed in Table 4-68. The majority of these indicator chemicals are volatile organic species associated with fuel and degreasing operations.

The following migration pathways for movement of contaminants from the site have been identified:

- Soil --> groundwater
- Soil --> groundwater --> stormwater drainage system --> surface water

Access to ERMP is restricted because it is an active area on the flightline. It is estimated that over 100 persons are working in nearby hangars within 1,000 feet of the perimeter of the site on a day-to-day basis.

In addition to normal operations that may have introduced contamination to this site, base records indicate that approximately 6,000 gallons of JP-4 fuel was spilled at an unspecified location on ERMP and that the bulk of the fuel spill percolated into adjacent soils.

Soil contamination at this site occurs at low levels and is limited in the number of contaminants. Soil contamination is subsurface and likely does not represent a direct contact hazard to base personnel. Exposure to airborne volatile contaminants released from subsurface soils would not represent a hazard because of low levels of contamination, slow release, and rapid dilution of volatilized chemicals in air. The limited low-level contamination at the site will most likely not represent a hazard even if contaminated soils are exposed during remedial activities. However, air monitoring data would be required to confirm the absence of an inhalation hazard.

Table 4-66

Analyte Concentrations in ERMP Groundwater Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
TDS		2×10^2	N/A	N/A	N/A	N/A	N/A
07-102-M021	5.5×10^2	X	---	---	---	---	---
07-103-M021	1.2×10^3	X	---	---	---	---	---
07-104-M021	6.4×10^2	X	---	---	---	---	---
07-136-M021	8.2×10^2	X	---	---	---	---	---
07-237-M021	1.3×10^4	X	---	---	---	---	---
07-138-M021	7.4×10^2	X	---	---	---	---	---
07-239-M021	3.5×10^2	X	---	---	---	---	---
07-140-M021	7.0×10^2	X	---	---	---	---	---
07-241-M021	1.2×10^3	X	---	---	---	---	---
07-142-M021	7.2×10^2	X	---	---	---	---	---
07-243-M021	6.3×10^2	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreememt Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-66
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
IDS		N/A	N/A	N/A	N/A	N/A
07-102-M021	5.5×10^{2}	---	---	---	---	---
07-103-M021	1.2×10^{3}	---	---	---	---	---
07-104-M021	6.4×10^{2}	---	---	---	---	---
07-136-M021	8.2×10^{2}	---	---	---	---	---
07-237-M021	1.3×10^{4}	---	---	---	---	---
07-138-M021	7.4×10^{2}	---	---	---	---	---
07-239-M021	3.5×10^{2}	---	---	---	---	---
07-140-M021	7.0×10^{2}	---	---	---	---	---
07-241-M021	1.2×10^{3}	---	---	---	---	---
07-142-M021	7.2×10^{2}	---	---	---	---	---
07-243-M021	6.3×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-67

Analyte Concentrations in ERMP Surface Water Exceeding Standards, IRP Stage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Benzene		N/A	N/A	5×10^{-3}	N/A	N/A	6.6×10^{-3}
07-521-W002	1.1×10^{-2}	---	---	X	---	---	X
07-523-W002	4×10^{-3}	---	---	X	---	---	X
TDS		2×10^{2}	N/A	N/A	N/A	N/A	N/A
07-521-W021	6.9×10^{2}	X	---	---	---	---	---
07-522-W021	5.0×10^{2}	X	---	---	---	---	---
07-523-W021	5.3×10^{2}	X	---	---	---	---	---
07-521-W022	5.7×10^{2}	X	---	---	---	---	---
07-522-W022	4.6×10^{2}	X	---	---	---	---	---
07-523-W022	4.4×10^{2}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreememt Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-67
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Benzene		6.7×10^{-3}	5×10^{-3}	0	N/A	0
07-521-W002	1.1×10^{-2}	[illegible]	X	X	---	X
07-523-W002	4×10^{-3}	---	---	X	---	X
TDS		N/A	N/A	N/A	N/A	N/A
07-521-W021	6.9×10^{2}	---	---	---	---	---
07-522-W021	5.0×10^{2}	---	---	---	---	---
07-523-W021	5.3×10^{2}	---	---	---	---	---
07-521-W021	5.7×10^{2}	---	---	---	---	---
07-522-W021	4.6×10^{2}	---	---	---	---	---
07-523-W021	4.4×10^{2}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-68

Contaminants of Concern at ERMP, IRP Stage 2, Selfridge ANGB, MI

Contaminant	Maximum Concentration Detected in Medium: Soil (mg/kg)	Groundwater (mg/L)	Surface Water (mg/L)
1,1,1-Trichloroethane	0.000002		
Benzene[a]			0.035[b]
Carbon disulfide	0.000082		
Ethylbenzene	0.000032	0.005	0.02
Toluene		0.006	0.178
Xylenes			0.038

[a]Known/suspected carcinogen (oral route).
[b]Exceeds EPA drinking water Maximum Contaminant Level.

The maximum benzene concentrations in these waters exceeds EPA drinking water Maximum Contaminant Levels. Groundwater contamination was not as high as that detected in the stormwater drainage system. Although groundwater percolation into the stormwater drainage system occurs at this site as well as the rest of the base sites, based upon potentiometric surface maps, the contribution of contamination from contaminated groundwater from this site is relatively low. Direct contact with groundwater on base is not likely because there are no operational base water supply wells. Contact with stormwater discharge at the Clinton River or Lake St. Clair is possible; therefore, the potential for downstream receptors to be exposed to concentrations of benzene in water in excess of Federal standards must be considered.

Surface water samples from ERMP were collected from the stormwater drainage system. All indicator chemicals in surface water were volatile organic species at concentrations relatively high compared to levels found at other base sites.

4.11 DISCUSSION AND SIGNIFICANCE OF FINDINGS -- BASE COAL STORAGE PILE

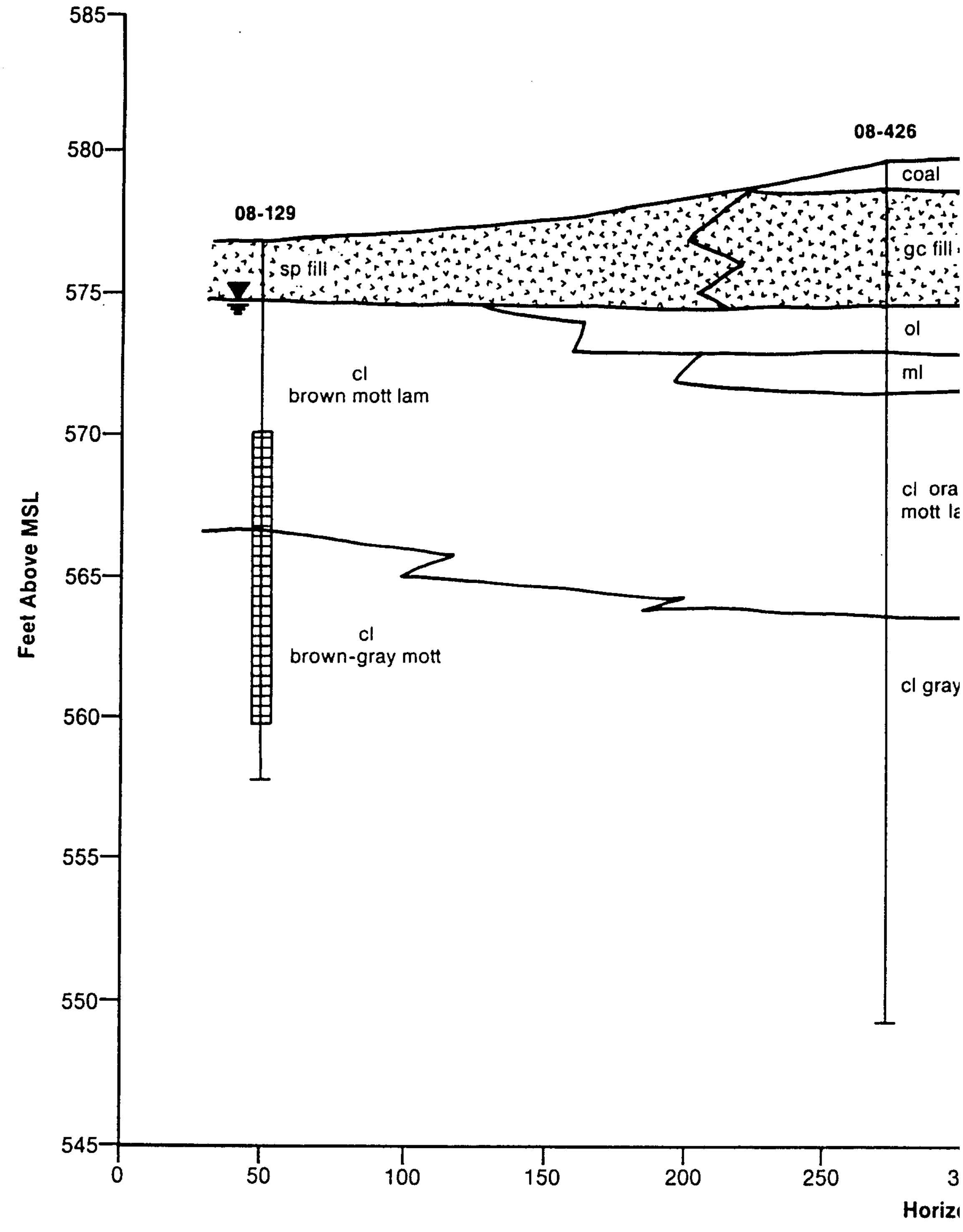
4.11.1 Pathway Characterization and Migration Potential -- BCSP

4.11.1.1 Subsurface Conditions -- BCSP

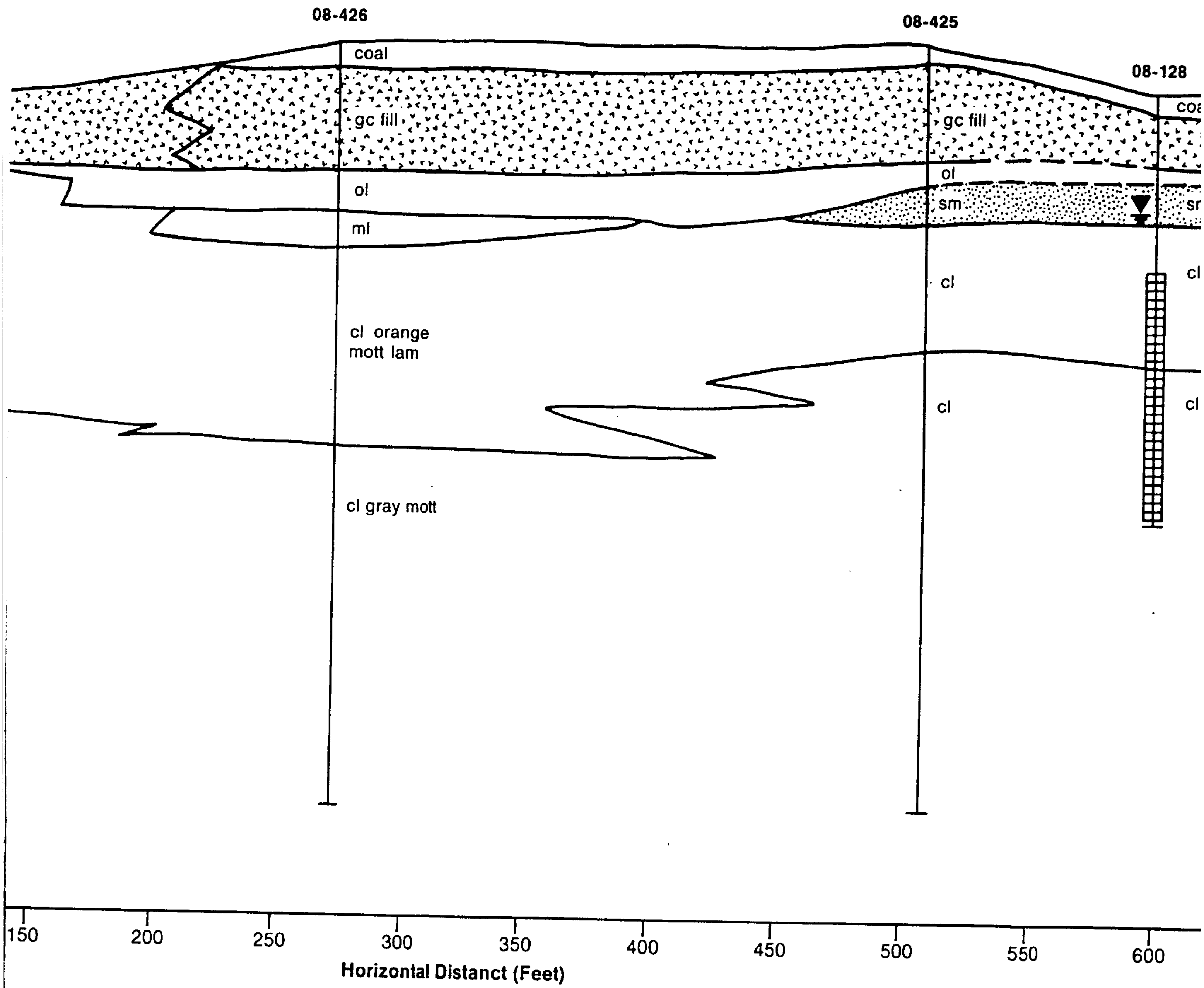
Based upon information from the boring logs, two cross sections (see Figures 4-74 and 4-75) were constructed showing profiles of the BCSP. The trace of the cross sections is shown in Figure 4-76. The relationship of the fill material and lacustrine unit can be seen in these cross sections. Three soil borings (08-425, 08-426, and 08-427) were drilled at BCSP to a depth of 30 feet BLS. They encountered predominantly gray clay to silty clay. The first 5 feet of each soil boring included 0.5 to 2 feet of bituminous coal pieces overlying approximately 3 feet of gravel and sand aggregate fill material. Approximately 1 to 2 feet of silt, topsoil, and black clay were found beneath the aggregate fill material. Brown silty sand and sand were present at 6 feet BLS in soil boring 08-427. Brown to gray mottled and laminated clay and silt were present in all BCSP soil borings from 8 to 12 feet. This sediment represents the upper part of the lacustrine unit. Gray clay to silty clay was encountered beneath the laminated clay and silt to the base of each soil borehole.

The top of the saturated zone, based upon the visual observation of soil cores, was reached between 7 and 16 feet BLS during drilling of the soil borings. The depth to water rose in soil boring 08-427 from between 7.5 and 10 feet, the level encountered during drilling, to 5.9 feet BLS in less than 2 hours following the completion of the borehole.

North A



Feet Above MSL
585
580
575
570
565
560
555
550
545
08-129
08-426
coal
sp fill
gc fill
ol
ml
cl
brown mott lam
cl ora
mott la
cl
brown-gray mott
cl gray
0
50
100
150
200
250
3
Horiz



08-426
08-425
08-128
coal
gc fill
gc fill
coa
ol
ol
ml
sm
sr
cl
cl
cl orange
mott lam
cl
cl
cl gray mott
150
200
250
300
350
400
450
500
550
600
Horizontal Distanct (Feet)

FIGUR

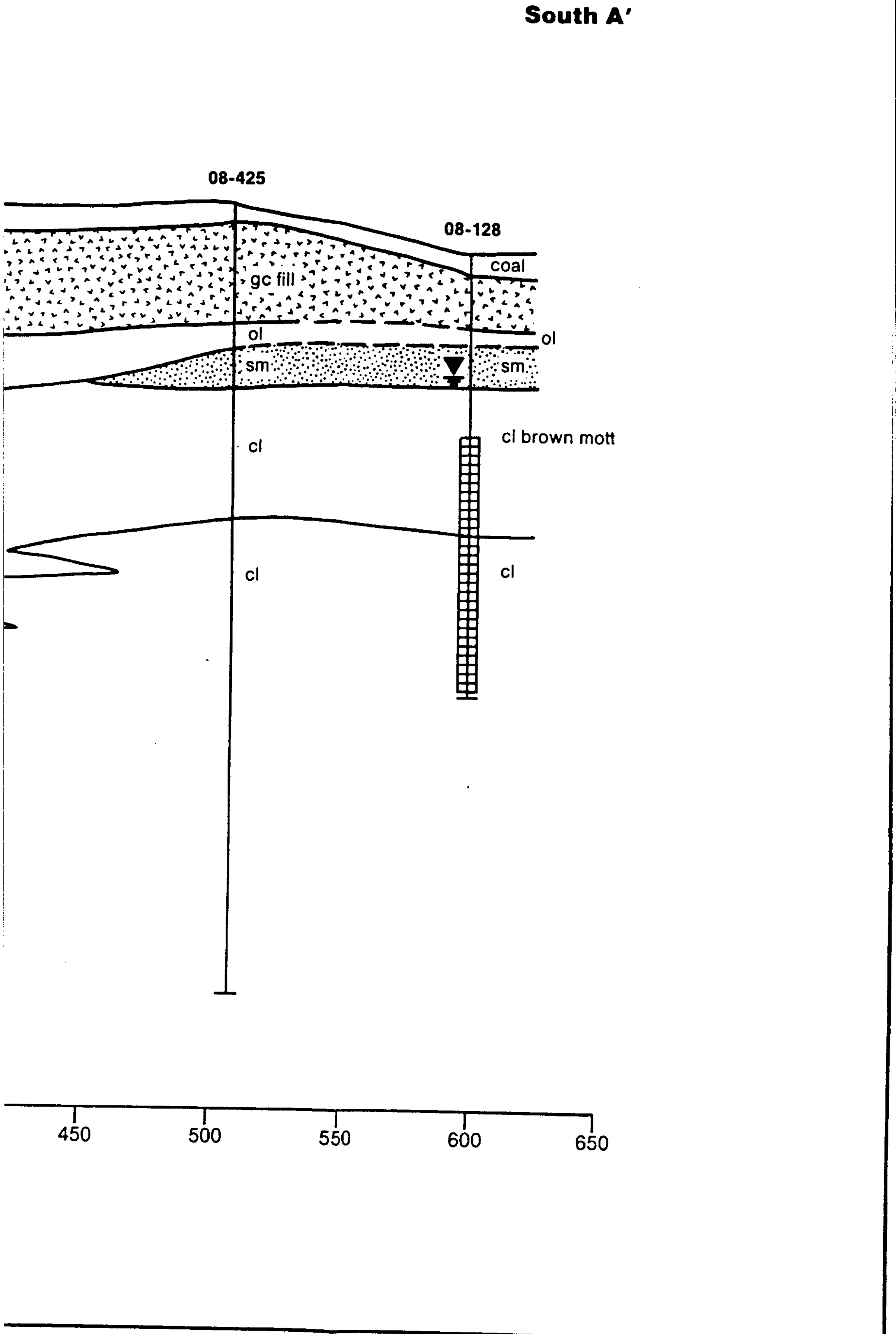


FIGURE 4-74 BCSP GEOLOGIC CROSS SECTION A-A'

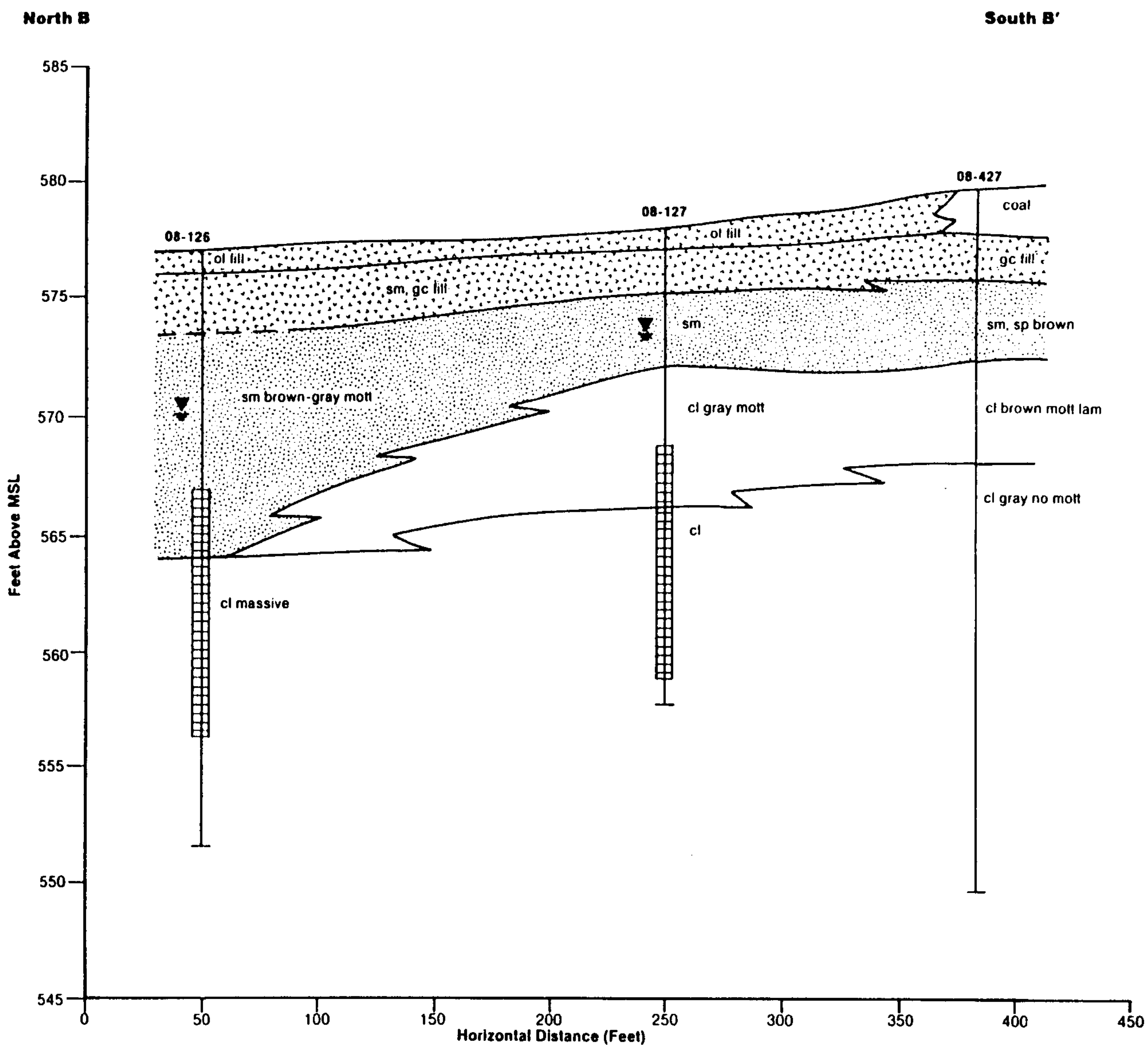
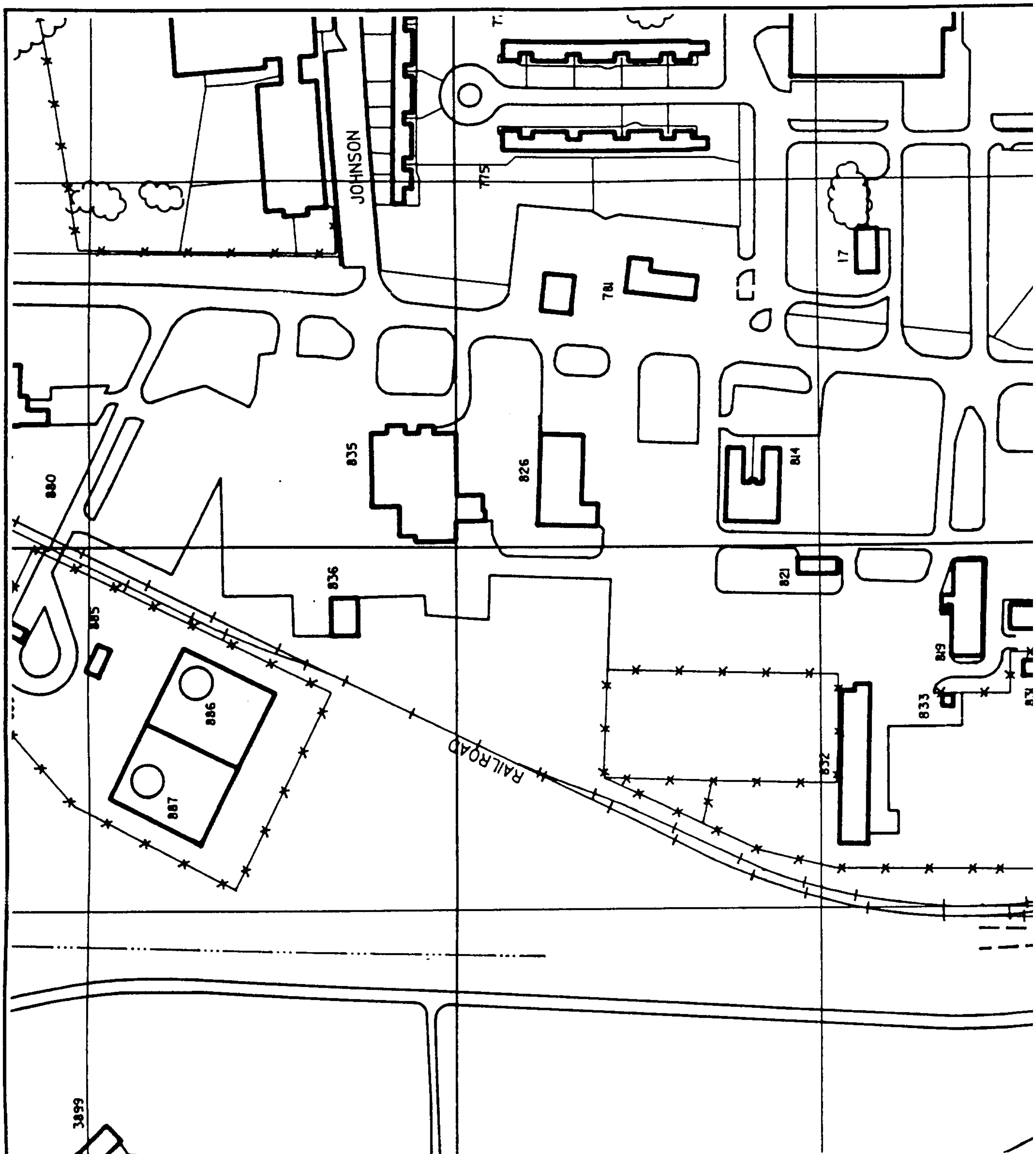


FIGURE 4-75 BCSP GEOLOGIC CROSS SECTION B-B'



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

N

0 100 200 400

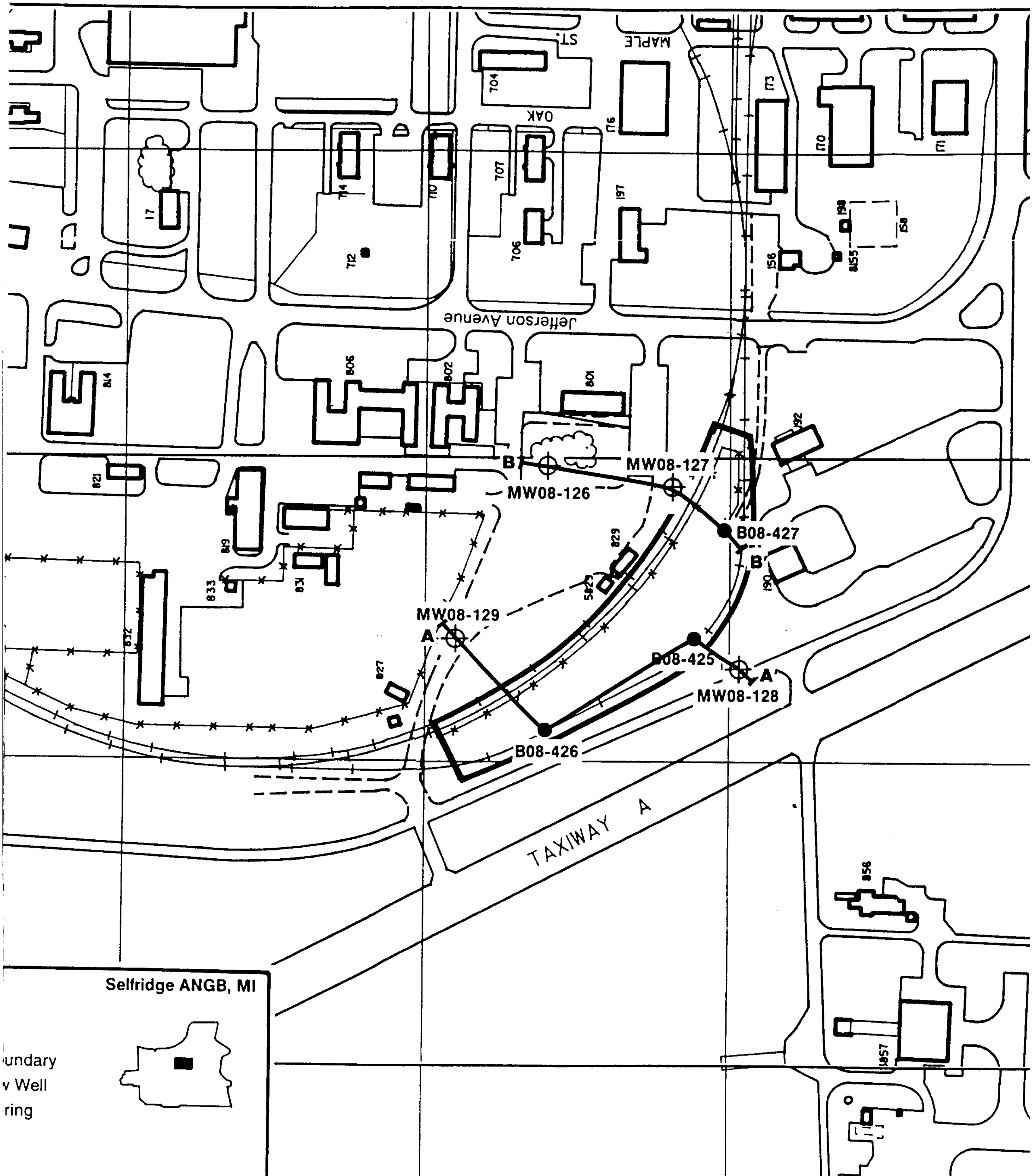
Scale in Feet

Legend

Site Boundary

MW08-126 Shallow Well

B08-426 Soil Boring


MAPLE
ST.
OAK
Jefferson Avenue
MW08-127
MW08-126
B08-427
MW08-129
B08-425
MW08-128
B08-426
A
B
TAXIWAY A
Selfridge ANGB, MI
undary
v Well
ring

FIGURE

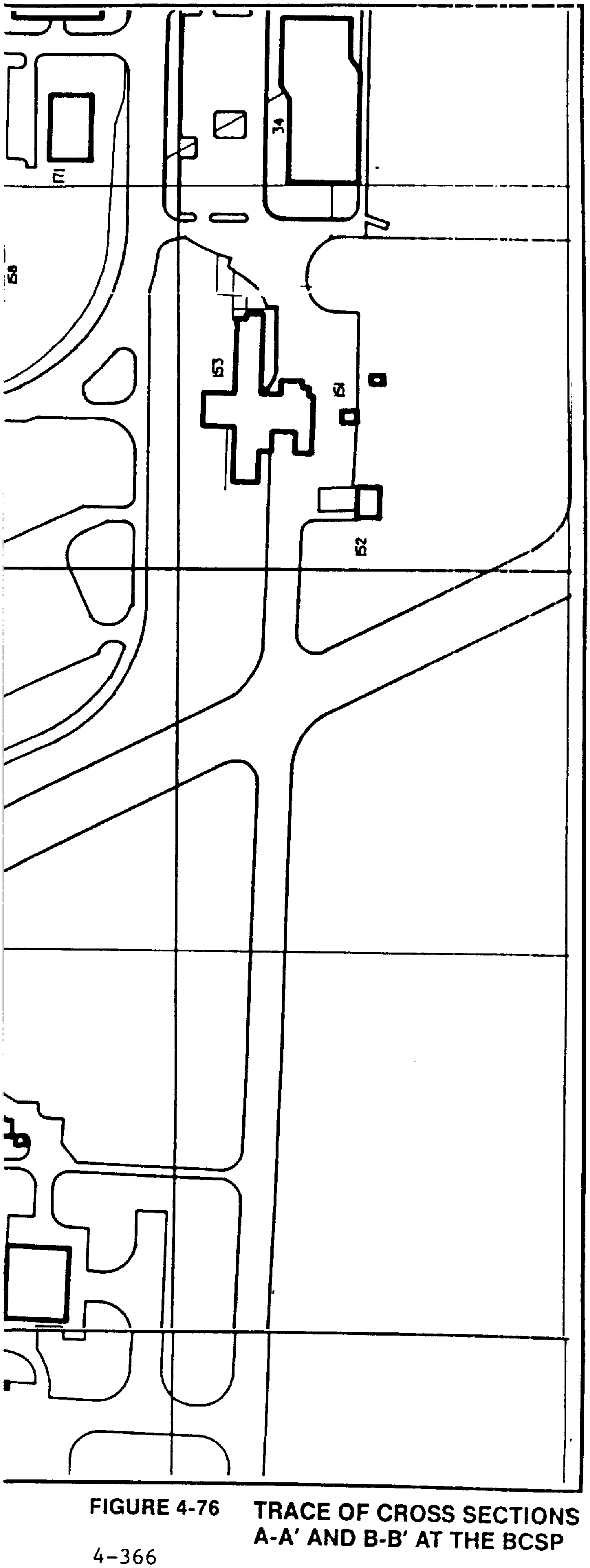


FIGURE 4-76 TRACE OF CROSS SECTIONS A-A' AND B-B' AT THE BCSP

OVA readings of soil samples obtained from soil borings 08-425 and 08-426 did not exceed 2 units. The background OVA reading at the BCSP site was 1 unit. OVA measurements from soil boring 08-427 ranged from 1 to 15 units for soil samples obtained below 10 feet. There were no visible signs of contamination observed nor any unusual odors noted during drilling of the soil borings at the BCSP site.

Four monitor wells (08-126 through 08-129) were installed with 10-foot screens to depths ranging from 17 to 21 feet. The lithology of the screened interval generally consisted of mottled, laminated, brown silty clay and an underlying gray clay to silty clay. During drilling of the groundwater monitor wells at BCSP the top of the saturated zone was reached between depths of 7 and 16 feet.

OVA readings of soil samples obtained from the groundwater monitor well borings at BCSP were generally at or within 1 unit of background levels. The maximum reading for each monitor well borehole did not exceed 10 units. The maximum OVA readings at the site were 4 to 10 units and 3 to 9 units in samples taken from the 15- to 20-foot interval in monitor well borings 08-126 and 08-129, respectively.

Two stormwater drainage pipes or agricultural drainage tiles are located underneath the BCSP. Installation of these agricultural drainage tiles probably occurred prior to the addition of fill material across the site. According to construction diagrams of the stormwater drainage system, no catch basins exist to drain the BCSP. These tiles appear to perform the function of agricultural drain tile lines and serve to intercept groundwater under the BCSP. Water intercepted by the tiles flows into the stormwater drainage system where it is eventually discharged to the Clinton River.

4.11.1.2 Extent and Character of Unsaturated Zone -- BCSP

No natural soils are found at the BCSP. Locally, a soil horizon has developed in the fill material added to the site. An organic-rich layer was also encountered beneath the fill material which may represent the former land surface prior to development.

Beneath the active surface of the BCSP a 0.5- to 2-foot layer of coal was encountered. Underneath this is a layer of gravel fill that may have served as the original surface onto which coal was off-loaded from railroad cars. This gravel fill may also have been emplaced as part of the foundation for the railroad spur passing along the western side of the site. Near the periphery of the site a sand layer was penetrated during drilling. The distribution of the sand at the BCSP is shown by the isopach map in Figure 4-7. As shown in Figure 4-75, the upper portion of the sand represents fill material. The lower portion of the

sand ranges in thickness from 0 to 9.5 feet and occurs at approximately 3 feet BLS. This lower unit of sand appears to be a natural deposit of either beach or alluvial origin.

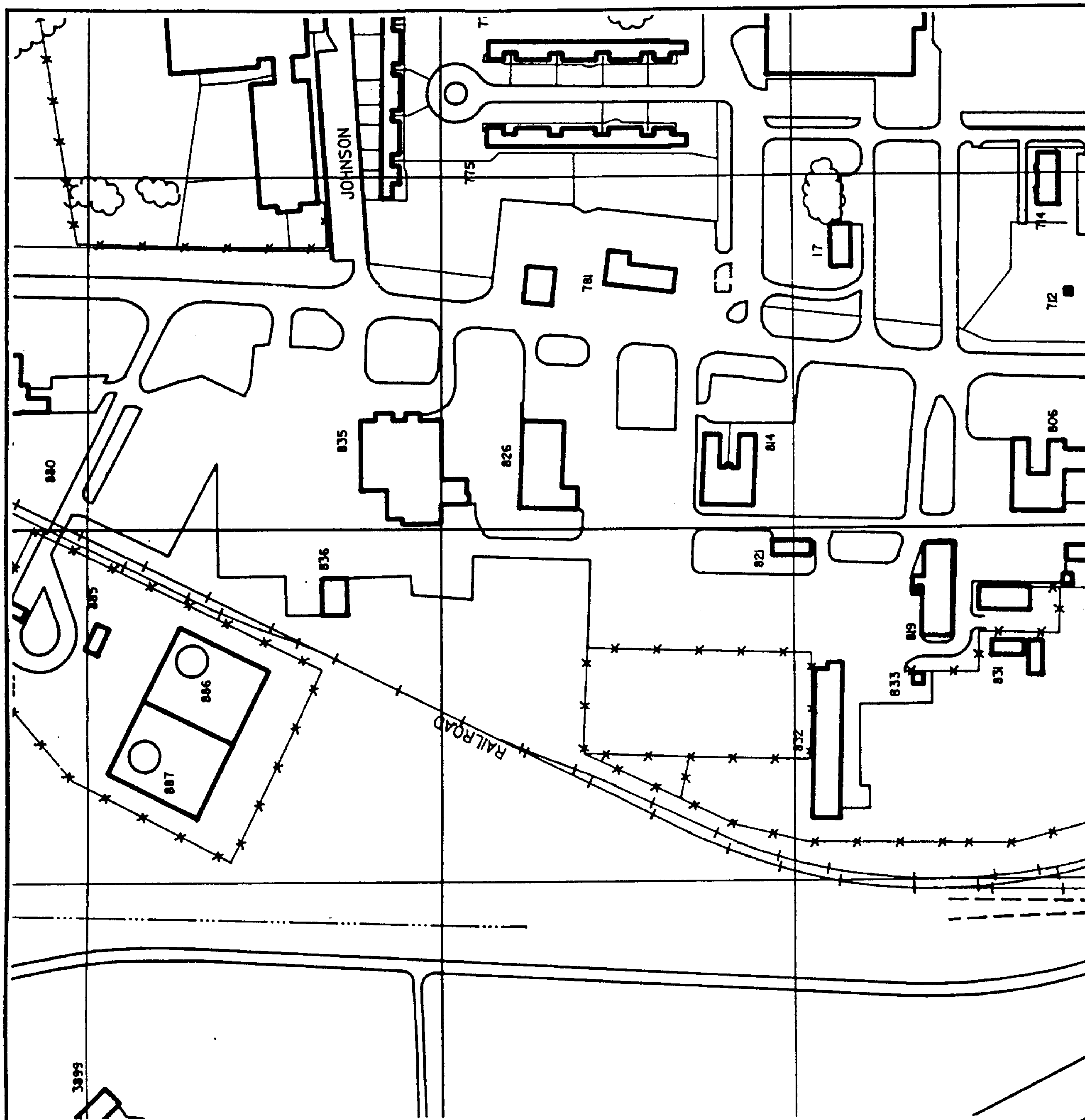
4.11.1.3 Groundwater Conditions -- BCSP

Clays of the lacustrine unit are the dominant lithology at the BCSP, as displayed in Figures 4-74 and 4-75. The clays are gray and contain a silt fraction. Saturated conditions in this material produce a very soft and sticky clay. The top of the saturated zones, based upon observation of mottling and amount of moisture, occurs between 7 and 16 feet BLS. At soil boring 08-426 saturated conditions were observed at a depth of 16 feet BLS.

Groundwater levels in the four shallow monitor wells at the BCSP were measured seven times between 1 February and 1 August 1988. The highest water level for all monitor wells was observed on 21 March 1988. Following this period levels in the monitor wells generally declined. A comparison of water levels in the monitor wells to the surface elevation of Lake St. Clair prior to 21 March 1988 reveals that water levels in monitor wells 08-127 and 08-129 were higher than the lake. The water levels in monitor wells 08-126 and 08-128 for this period were below the surface elevation of Lake St. Clair. For the period 10 May to 1 August 1988 the water levels in monitor wells 08-126, 08-127, and 08-128 were consistently below the surface elevation of Lake St. Clair. During this same period the water level in monitor well 08-129 was found to be always higher than the surface elevation of Lake St. Clair.

The groundwater potentiometric maps for the BCSP (see Figure 4-77 for 21 March and Figure 4-78 for 1 August 1988) are representative of all the potentiometric surface maps for each of the measurement periods. Based upon the water level data for all measurement periods between 1 February and 1 August 1988, a groundwater divide exists along a line between monitor wells 08-127 and 08-129. Groundwater flow from the BCSP along this divide diverges in a northeasterly direction and in a southerly direction. As a result of this flow pattern, well 08-128 is located in a downgradient position with respect to the BCSP, and monitor well 08-129 serves as the most upgradient well. A horizontal gradient of 0.02 ft/ft was calculated based upon the potentiometric surface maps of water levels at the BCSP.

Hydraulic conductivities were measured at the four BCSP monitor wells using baildown recovery tests (see Appendix I). Hydraulic conductivities are presented in Table 3-18. The average hyraulic conductivity at the BCSP is 1.28×10^{-6} ft/sec (3.9×10^{-5} cm/sec). Monitor wells 08-126 and 08-127 have higher hydraulic conductivity values than the other two monitor wells by a factor of 10 (see Table 3-18). Relatively little difference in hydraulic conductivity exists between monitor well



(Source: Michigan Air National Guard Base Comprehensive Plan 1987)

Selfridge ANGB, MI

Legend

	Site Boundary	**573**	Potentiometric Surface Contour
MW08-126	Shallow Well	**(575.09)**	Groundwater Elevation (Feet)
B08-426	Soil Boring		Groundwater Flow Direction

N

0 100 200 400

Scale in Feet

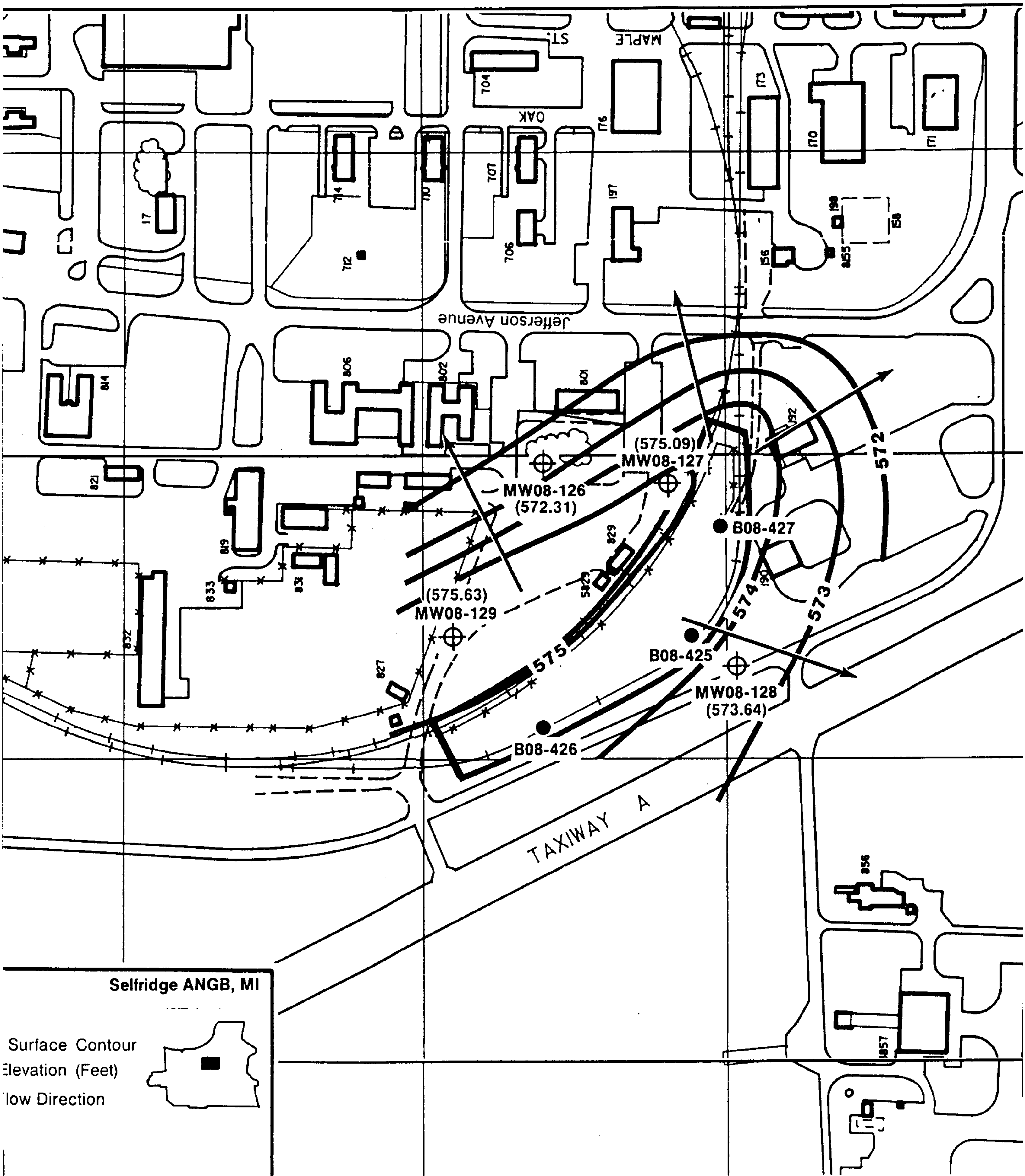

Selfridge ANGB, MI
Surface Contour
Elevation (Feet)
low Direction
MW08-126
(572.31)
(575.09)
MW08-127
(575.63)
MW08-129
MW08-128
(573.64)
B08-427
B08-425
B08-426
575
574
573
572
Jefferson Avenue
OAK
MAPLE
ST.
TAXIWAY A

FIGURE 4-77

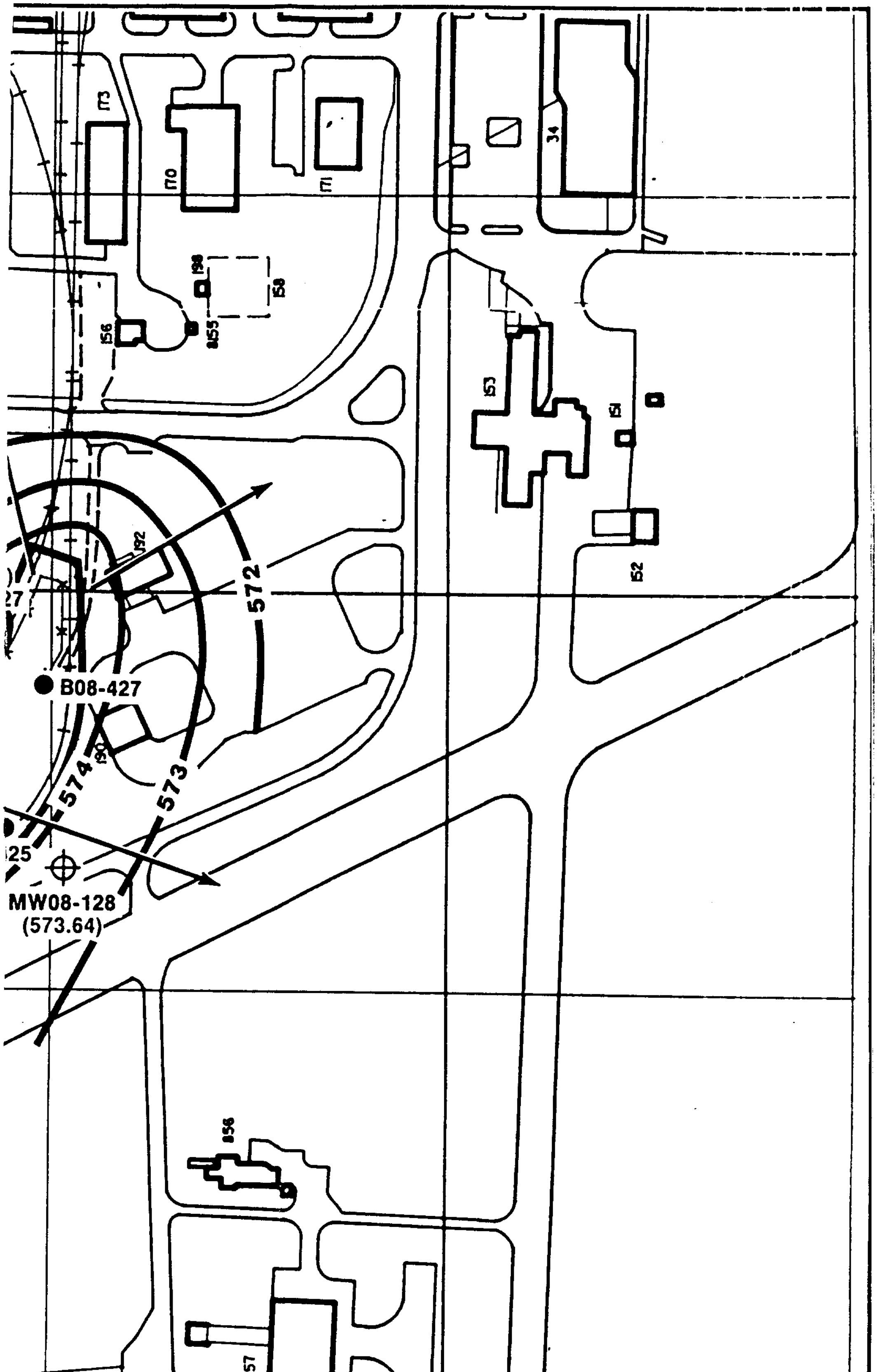
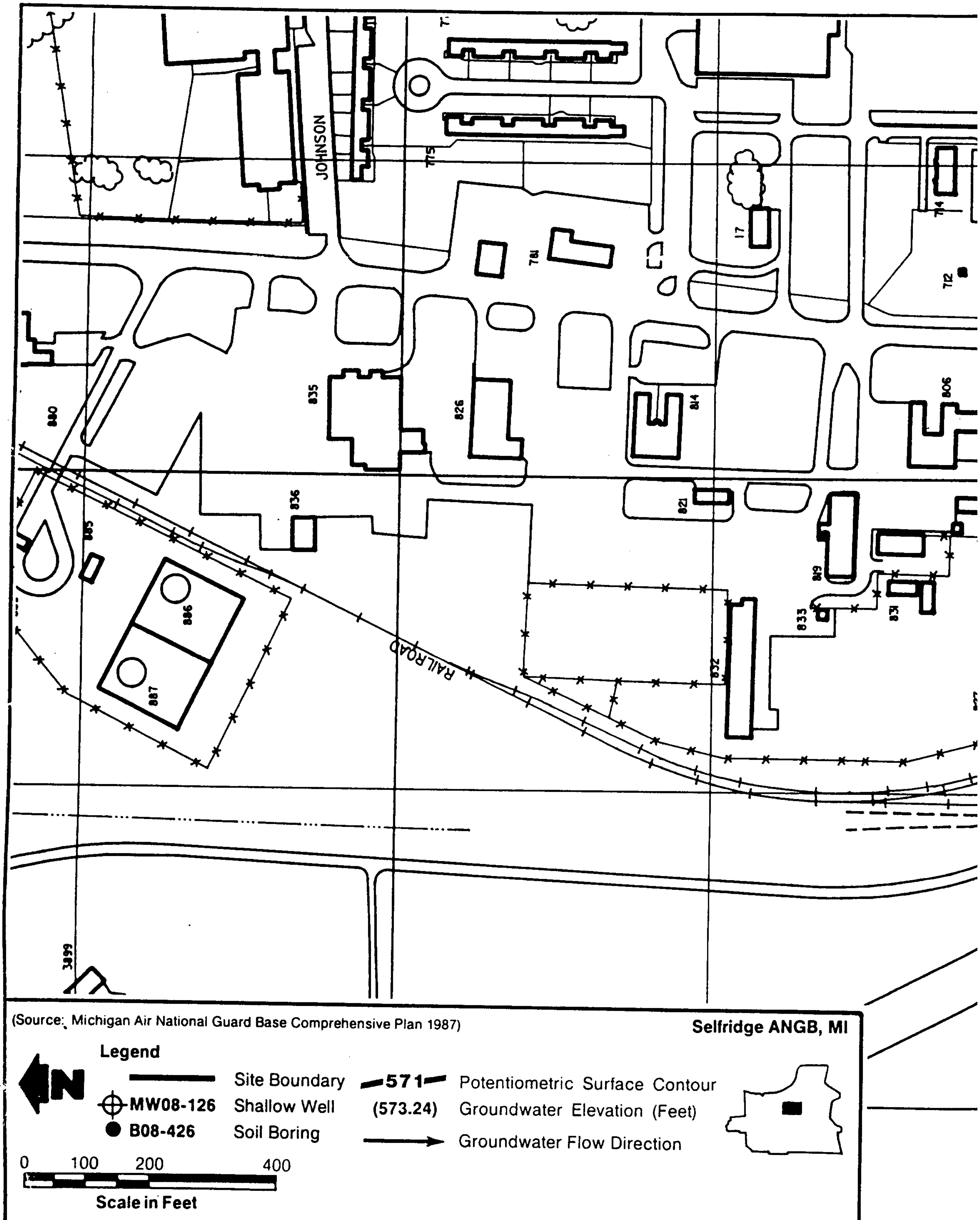


FIGURE 4-77 BCSP POTENTIOMETRIC SURFACE MAP FOR 21 MARCH 1988



JOHNSON
RAILROAD
715
781
17
714
712
835
826
814
806
880
836
821
819
885
886
887
833
831
832
3899
(Source: Michigan Air National Guard Base Comprehensive Plan 1987)
Selfridge ANGB, MI
Legend
N
Site Boundary
MW08-126 Shallow Well
B08-426 Soil Boring
571 Potentiometric Surface Contour
(573.24) Groundwater Elevation (Feet)
Groundwater Flow Direction
0 100 200 400
Scale in Feet

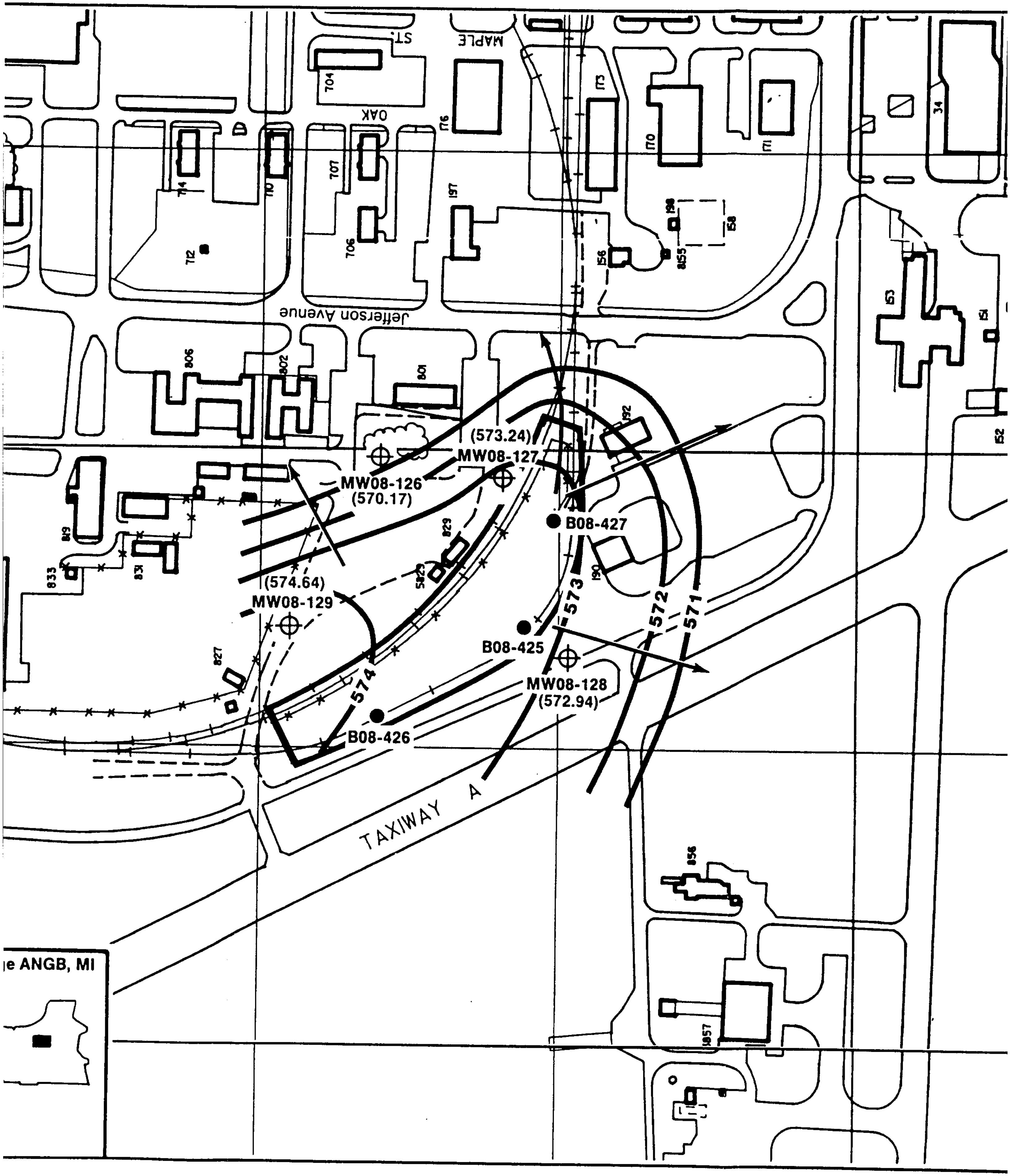


FIGURE 4-78 BCSP POTENTIC
MAP FOR 1 AUG

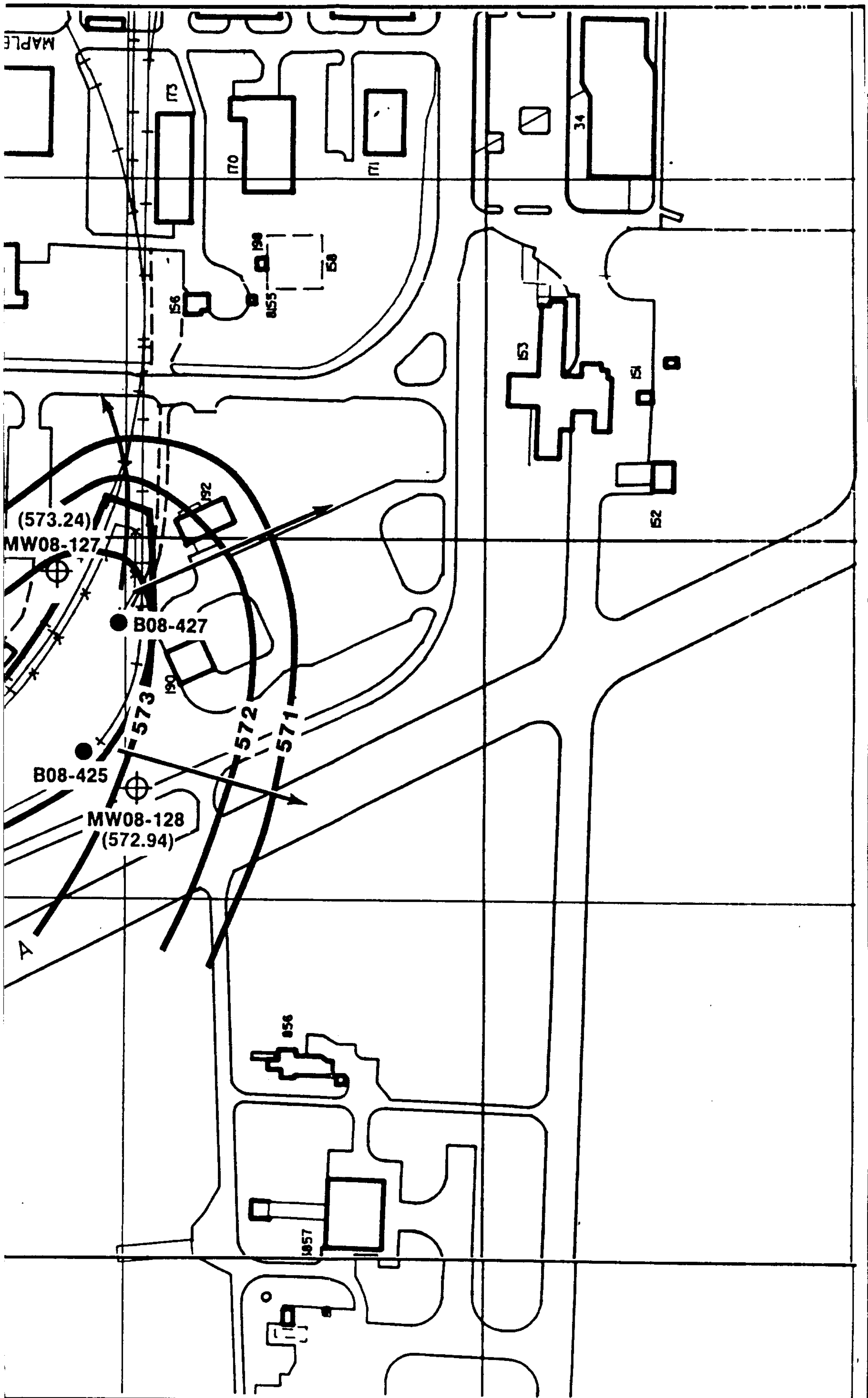


FIGURE 4-78 BCSP POTENTIOMETRIC SURFACE MAP FOR 1 AUGUST 1988

08-126, which is partially screened in sand, as compared to monitor well 08-127, which is screened in clay.

The effective porosity of soils at the site was estimated to be 15 percent. Using the values for gradient, effective porosity, and the average hydraulic conductivity, the groundwater flow velocity was calculated for the periods of 21 March and 1 August 1988 to be 1.71 x 10^{-7} ft/sec (5.39 ft/year).

4.11.1.4 Surface Drainage and Potential for Impacts to Surface Water Quality -- BCSP

No provisions are made to prevent precipitation from coming in contact with coal stored at the BCSP. The site also lacks features to control or contain surface water runoff. Snowmelt water and stormwater runoff either drain off the area or pond on the surface of the site and infiltrate into the ground. The effectiveness of the agricultural drain tile system in intercepting groundwater underneath the BCSP is unknown. The system appears to collect some groundwater, based upon its design. Water captured in this tile system would be channeled through the stormwater drainage system and be discharged into the Clinton River.

Surface water runoff may pond on the active surface of the BCSP or accumulate in the low-lying areas along the sides of the site. A portion of the runoff moving off the BCSP would be intercepted by the drainage ditches located along roadways adjacent to the site. The runoff is routed to stormwater catch basins. Water intercepted by these catch basins is drained to the pump lift stations and discharged into the Clinton River.

4.11.1.5 Direct Contact with Contaminated Media -- BCSP

The BCSP is periodically an active area for off-loading of coal and its distribution to base facilities. Direct contact with the coal by workers can occur during work at the BCSP.

Workers performing maintenance activities around the BCSP could come in contact with any contaminants in the soils or surface water runoff at the site. Visitors to the area could also come in direct contact with contaminants at the site because there are no physical means of restricting access to the site.

4.11.1.6 Summary of Migration Pathways -- BCSP

Excavation into the ground along the BCSP by base personnel could expose contaminated soils. Activities requiring trenching are likely because of the large number of utilities passing directly by or under the site. These activities would result in direct contact with contaminants from the BCSP.

Acidic water may be produced when pyrite contained in the coal reacts with air and water. Contaminants such as heavy metals

contained in the coal can also be taken into solution or suspension. Uncontrolled surface water runoff collects on and along the parking lot to the east of the site and roadways passing by all sides of the BCSP. Use of the parking lot by base personnel and visitors creates a situation where direct contact with contaminated surface water could occur.

Any contaminated groundwater that infiltrates under the BCSP could be intercepted by the stormwater drainage tiles beneath the site. This water is then routed through the drainage network and discharged into the Clinton River.

During periods when the coal is physically moved, either during unloading or loading, coal dust may be generated and released into the atmosphere. Also, because the coal is not covered, direct dispersal of coal dust by the wind could occur. Both of these activities could result in coal contaminants being entrained into the atmosphere and transported throughout the base and potentially beyond the base boundaries.

4.11.2 Contamination Profile -- BCSP

4.11.2.1 Chemical Results for Soil -- BCSP

Nine investigative soil samples were collected from three soil borings and were analyzed for chemical contaminants during the IRP Stage 2 investigation. The nine soil samples were taken from soil borings 08-425, 08-426, and 08-427. The borings were located at approximately equidistant points around the perimeter of the site. The soil samples were collected to investigate possible soil contamination by the coal and leachate from the coal.

The soil borings were drilled and soils samples were collected on 9 January and 10 January 1988. The soils were sent to WESTON/Gulf Coast Laboratories and were analyzed for semivolatile organics, soil moisture content, and metals screen including arsenic, mercury, and selenium. No holding times were exceeded for these samples. The surrogate recoveries for the semivolatile analyses ranged from 1 to 91 percent. The analyses for soil sample 08-426-B003 had very low surrogate recoveries (1, 3, 6, 28, 31, and 83 percent), but all detection limits for semivolatile analyses were within acceptable limits. Matrix spike recoveries for the metals screen ranged from 92.4 to 104 percent.

Valid analytes and concentrations detected in soil samples from the BCSP are listed in Table 4-69. There were no semivolatile contaminants detected in any of the soil samples analyzed from the BCSP. The metals screen analyses detected arsenic (5.9 to 15.9 mg/kg) in six soil samples and cadmium (1 to 1.4 mg/kg) in four soil samples, but all of these concentrations were within the background ranges set in the statistical analysis listed in

TABLE 4-69

VALID ANALYTES DETECTED IN SOIL AT BCSP,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE #	08-425-B001			08-425-B002			08-425-B003			08-426-B001			08-426-B002			08-426-B003		
	RFW #	121391			121392			121393			121394			121395			121396		
	SAMPLE DATE	09-JAN-88			09-JAN-88			09-JAN-88			09-JAN-88			09-JAN-88			09-JAN-88		
	DEPTH	5-10 FEET			10-15 FEET			20-25 FEET			5-9.3 FEET			10-15 FEET			25-30 FEET		
	% MOISTURE	11.0			21.1			37.8			18.7			20.4			34.7		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ALUMINUM, TOTAL	SW3050/SW6010	19.7	5490	=	19.8	10500	=	19.9	13600	=	18.8	8310	=	19.5	11800	=	19.2	12600	=
ARSENIC, TOTAL	SW3050/SW7060	4.8	5.9	=	9.6	10.5	=	19.5		ND	4.9	13.3	=	10	15.9	=	9.4	15.7	=
BORON, TOTAL	SW3050/SW6010	19.7		ND	19.8		ND	19.9	27	=	18.8		ND	19.5	22	=	19.2	26.6	=
BARIUM, TOTAL	SW3050/SW6010	2.5	38.3	=	2.5	87	=	2.5	111	=	2.3	62.4	=	2.4	85.2	=	2.4	96.7	=
BERYLLIUM, TOTAL	SW3050/SW6010	.20	0.36	=	0.2	0.74	=	0.2	0.93	=	0.19	0.56	=	0.2	0.79	=	0.19	0.88	=
CALCIUM, TOTAL	SW3050/SW6010	9.8	32100	=	9.9	33200	=	10	60900	=	9.4	11900	=	9.8	43500	=	9.6	41700	=
CADMIUM, TOTAL	SW3050/SW6010	1.0		ND	0.99	1.3	=	1		ND	0.94		ND	0.98	1.3	=	0.96	1.4	=
COBALT, TOTAL	SW3050/SW6010	3.9	4.4	=	4	11.7	=	4	13	=	3.8	7.31	=	3.9	12.1	=	3.8	12.4	=
CHROMIUM, TOTAL	SW3050/SW6010	2.0	9.3	=	2	18.2	=	2	22.8	=	1.9	15.5	=	2	18.7	=	1.9	20.9	=
IRON, TOTAL	SW3050/SW6010	3.9	9430	=	4	19800	=	4	23700	=	3.8	17300	=	3.9	23200	=	3.8	23400	=
POTASSIUM, TOTAL	SW3050/SW6010	984		ND	990	1740	=	996	2620	=	939		ND	976	1880	=	960	2630	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.7	3590	=	19.8	14900	=	19.9	11300	=	18.8	4740	=	19.5	14000	=	19.2	11500	=
MANGANESE, TOTAL	SW3050/SW6010	.98	151	=	0.99	479	=	1	433	=	0.94	336	=	0.98	802	=	0.96	363	=
SODIUM, TOTAL	SW3050/SW6010	88.6	990	=	89.1	1080	=	89.6	1830	=	84.5	924	=	87.8	1060	=	86.4	1440	=
NICKEL, TOTAL	SW3050/SW6010	4.9	9.2	=	5	28.1	=	5	33.7	=	4.7	18.6	=	4.9	29.2	=	4.8	35.4	=
SILICON, TOTAL	SW3050/SW6010	19.7	268	=	19.8	300	=	19.9	320	=	18.8	228	=	19.5	150	=	19.2	140	=
VANADIUM, TOTAL	SW3050/SW6010	3.9	41.1	=	4	22.7	=	4	23.2	=	3.8	22.1	=	3.9	22.8	=	3.8	25.4	=
ZINC, TOTAL	SW3050/SW6010	.98	24.3	=	0.99	58.8	=	1	62.4	=	0.94	43.3	=	0.98	58.6	=	0.96	64.7	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

TABLE 4-69

(CONTINUED)

	SAMPLE # / RFW # / SAMPLE DATE / DEPTH / % MOISTURE	08-427-B001 / 121468 / 10-JAN-88 / 5-7.5 FEET / 17.6			08-427-B002 / 121469 / 10-JAN-88 / 10-15 FEET / 24.9			08-427-B003 / 121470 / 10-JAN-88 / 15-20 FEET / 36.2		
ANALYTE	METHOD	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL	DL	R (mg/kg)	QL
ALUMINUM, TOTAL	SW3050/SW6010	19.4	2260	=	19.8	10800	=	19.4	13700	=
ARSENIC, TOTAL	SW3050/SW7060	2.4		ND	9.6		ND	9.6	11.7	=
BORON, TOTAL	SW3050/SW6010	19.4		ND	19.8	21.1	=	19.4	28.1	=
BARIUM, TOTAL	SW3050/SW6010	2.4	12.9	=	2.5	96.8	=	2.4	89.5	=
BERYLLIUM, TOTAL	SW3050/SW6010	0.19		ND	0.2	0.8	=	0.19	1	=
CALCIUM, TOTAL	SW3050/SW6010	9.7	20300	=	9.9	36900	=	9.7	31800	=
CADMIUM, TOTAL	SW3050/SW6010	0.97		ND	0.99		ND	0.97	1	=
COBALT, TOTAL	SW3050/SW6010	3.9		ND	4	12.4	=	3.9	12.9	=
CHROMIUM, TOTAL	SW3050/SW6010	1.9	5.5	=	2	17.4	=	1.9	22.4	=
IRON, TOTAL	SW3050/SW6010	3.9	3800	=	4	21000	=	3.9	25300	=
POTASSIUM, TOTAL	SW3050/SW6010	968		ND	991	1980	=	972	2660	=
MAGNESIUM, TOTAL	SW3050/SW6010	19.4	8230	=	19.8	15500	=	19.4	9740	=
MANGANESE, TOTAL	SW3050/SW6010	0.97	82.8	=	0.99	464	=	0.97	322	=
SODIUM, TOTAL	SW3050/SW6010	87.1	752	=	89.2	1340	=	87.5	1720	=
NICKEL, TOTAL	SW3050/SW6010	4.8	5.6	=	5	28.1	=	4.8	35.8	=
SILICON, TOTAL	SW3050/SW6010	19.4	165	=	19.8	204	=	19.4	199	=
VANADIUM, TOTAL	SW3050/SW6010	3.9	6.59	=	4	22.6	=	3.9	30.2	=
ZINC, TOTAL	SW3050/SW6010	0.97	12.4	=	0.99	59.9	=	0.97	56.6	=

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
ALL VALUES CORRECTED FOR PERCENT MOISTURE

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIME EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

Table 4-20, and all concentrations were within the naturally occurring observed range of these elements for the eastern conterminous United States (USGS Professional Paper 1270).

4.11.2.2 Chemical Results for Groundwater -- BCSP

One duplicate and four investigative water samples were collected from four shallow monitor wells, 08-126, 08-127, 08-128, and 08-129. One groundwater sample was taken from upgradient monitor well 08-126, and the other samples were taken from the three downgradient wells.

The groundwater samples were collected on 19 April and 23 April 1988. They were sent to WESTON/Gulf Coast Laboratories and were analyzed for extractable priority pollutants, acidity, alkalinity, common anions, TDS, and metals screen including arsenic, lead, mercury, and selenium. Holding times were exceeded for common anions, and TDS for groundwater samples 08-126-M001 and 08-128-M001 and TDS for 08-127-M001 and 08-127-M101. Monitor wells 08-126, 08-127, and 08-128 were resampled for these parameters on 20 June, 3 August, and 4 August 1988, and the samples were sent to WESTON/Gulf Coast Laboratories for analyses. The resampled groundwater was analyzed within holding time limits.

Surrogate recoveries for the semivolatile analyses ranged from 1 to 167 percent. The semivolatile surrogate recoveries for groundwater samples 08-126-M001 and 08-129-M001 were not within QC limits and were re-extracted. Low surrogate recoveries occurred again in the re-extracted samples, indicating matrix interference effect. All other surrogate recoveries and detection limits were within quality control limits.

Table 4-70 lists the valid analytes and concentrations detected in groundwater samples collected at the BCSP. Semivolatile analyses detected the common plasticizers bis(2-ethylhexyl) phthalate (<2 to 15 ug/L) and di-n-butyl phthalate (<1 to <2 ug/L) in groundwater samples 08-126-M001, 08-127-M001, 08-128-M001, and 08-129-M001. Anthracene (<1 ug/L), phenanthrene (<3 ug/L), and pyrene (<2 ug/L) were detected in groundwater sample 08-128-M001. No other semivolatile analytes were detected. The metals screen detected barium (0.143 to 0.882 mg/L) in each groundwater sample. The barium concentration detected in 08-126-M001 (0.882 mg/L) was the second-highest detected at Selfridge ANGB. Sample 08-126-M001 also contained nickel (0.088 mg/L) and zinc (0.053 mg/L). Sample 08-128-M001 contained copper (0.06 mg/L), nickel (0.047 mg/L), and zinc (0.096 mg/L). Sample 08-129-M001 contained cadmium (0.013 mg/L), copper (0.028 mg/L), nickel (0.073 mg/L), and barium (0.149 mg/L). The cadmium concentration exceeds the primary drinking water standard of 0.01 mg/L. No other metals detected exceeded drinking water standards.

TABLE 4-70

VALID DETECTED ANALYTES IN GROUNDWATER AT BCSP,
IRP STAGE 2, SELFRIDGE ANGB, MI

	SAMPLE # RFW # SAMPLE DATE		08-126-M001 129063 23-APR-88			08-127-M001 128520 19-APR-88			08-127-M101 128521 DUPLICATE 19-APR-88			08-128-M001 129064 23-APR-88			08-129-M001 128523 19-APR-88		
ANALYTE	METHOD	UNIT	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL	DL	R	QL
ANTHRACENE	E625	ug/L	10		ND	10		ND	10		ND	10	1	<	10		ND
BIS(2-ETHYLHEXYL) PHTHALATE	E625	ug/L	10	2	<	10	15	=	10	4	<	10	4	<	10	4	<
DI-N-BUTYL PHTHALATE	E625	ug/L	10	2	<	10		ND	10		ND	10	1	<	10	2	<
PHENANTHRENE	E625	ug/L	10		ND	10		ND	10		ND	10	3	<	10		ND
PYRENE	E625	ug/L	10		ND	10		ND	10		ND	10	2	<	10		ND
BORON, TOTAL	E200.7	mg/L	.100	0.317	=	.100	0.234	=	.100	0.245	=	.100	0.243	=	.100	0.22	=
BARIUM, TOTAL	E200.7	mg/L	.0500	0.882	=	.0500	0.144	=	.0500	0.143	=	.0500	0.345	=	.0500	0.149	=
CALCIUM, TOTAL	E200.7	mg/L	.200	371	=	.200	125	=	.200	125	=	.200	134	=	.200	1240	=
CADMIUM, TOTAL	E200.7	mg/L	.0050		ND	.0050		ND	.0050		ND	.0050		ND	.0050	0.013	=
COPPER, TOTAL	E200.7	mg/L	.0250		ND	.0250		ND	.0250		ND	.0250	0.06	=	.0250	0.028	=
IRON, TOTAL	E200.7	mg/L	.0400		ND	.0400		ND	.0400	0.058	=	.0400		ND	.0400		ND
POTASSIUM, TOTAL	E200.7	mg/L	5.00	5.53	=	5.00		ND	5.00		ND	5.00		ND	5.00	7.94	=
MAGNESIUM, TOTAL	E200.7	mg/L	.200	131	=	.200	36	=	.200	35.6	=	.200	54.5	=	.200	274	=
MANGANESE, TOTAL	E200.7	mg/L	.0100	1.42	=	.0100	0.265	=	.0100	0.26	=	.0100	0.567	=	.0100	2.42	=
SODIUM, TOTAL	E200.7	mg/L	9.00	766	=	.900	48.8	=	.900	47.5	=	9.00	349	=	90.0	2030	=
NICKEL, TOTAL	E200.7	mg/L	.0150	0.088	=	.0150		ND	.0150		ND	.0150	0.047	=	.0150	0.073	=
SILICON, TOTAL	E200.7	mg/L	.300	4.6	=	.300	4.58	=	.300	4.61	=	.300	5.05	=	.300	6.45	=
ZINC, TOTAL	E200.7	mg/L	.053	0.053	=	.053		NV	.053		NV	.053	0.096	=	.053	0.024	=
ACIDITY	E305.1	mg/L	10	39	=	10	37	=	10	30	=	10	26	=	10	190	=
ALKALINITY	A403	mg/L	10	240	=	10	390	=	10	420	=	10	340	=	10	480	=
FLUORIDE	E340.2	mg/L	0.1	0.2	=	0.1		NV	0.1		NV	0.1	0.2	=	0.1		NV
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10		HT	10		HT	10		HT	10		HT	10	12000	=
	SAMPLE # RFW # SAMPLE DATE		08-126-M021 8806-759-001 06-JUN-88			08-127-M001 8804-183-004 19-APR-88			08-127-M101 8804-183-005 19-APR-88			08-128-M021 8806-759-002 06-JUN-88			08-129-M001 8804-183-007 19-APR-88		
CHLORIDE	A429	mg/L	125	2090	=	25	74.3	=	25	79.1	=	125	1170	=	500	6800	=
SULFATE	A429	mg/L	25	116	=	25	143	=	25	117	=	25	74	=	2.5		ND
	SAMPLE # RFW # SAMPLE DATE		08-126-M001 137215 03-AUG-88			08-127-M001 137005 04-AUG-88						08-128-M001 136999 04-AUG-88			08-129-M001 137217 03-AUG-88		
NITRATE/NITRITE	E353.1	mg/L	0.1	0.2	=	0.1		ND				0.1	0.2	=	0.1		ND
	SAMPLE # RFW # SAMPLE DATE		08-126-M021 137216 03-AUG-88			08-127-M021 137006 04-AUG-88			08-128-M121 137001 04-AUG-88			08-128-M021 137000 04-AUG-88					
TOTAL DISSOLVED SOLIDS	E160.1	mg/L	10	5000	=	10	2900	=	10	1800	=	10	1700	=			

DL - SAMPLE DETECTION LIMIT
R - RESULT
QL - QUALIFIER
< - DETECTED AT CONCENTRATION BELOW SAMPLE DETECTION LIMIT
NUMBERS IN PARENTHESES ARE VALUES DETERMINED BY SECOND COLUMN

NV - NOT VALID
ND - NOT DETECTED
HT - HOLDING TIMES EXCEEDED; ANALYSIS NOT VALID
= - CONCENTRATION SHOWN IS VALID

Among the indicator parameters for all groundwater sampled at BCSP, sample 08-129-M001 contained the highest acidity (190 mg/L), chloride (6,800 mg/L), and TDS (12,000 mg/L). The chloride concentration was the greatest detected on base and the TDS the second highest detected on base. Groundwater sample 08-126-M001 contained chloride (2,090 mg/L) and TDS (5,000 mg/L); sample 08-127-M001 contained 2,900 mg/L TDS; and sample 08-128-M001 contained chloride (1,170 mg/L) and TDS (1,700 mg/L). All of these concentrations are above the Federal secondary (aesthetic) drinking water standards. In addition, the specific conductance as tested in the field was elevated for 08-126-M001 (3,410 to 3,550 micro-mhos per centimeter (umho/cm)), 08-127-M001 (2,100 to 2,750 umho/cm), 08-128-M001 (1,780 to 2,590 umho/cm), and for 08-129-M001 (6,800 to 6,950 umho/cm).

4.11.2.3 Chemical Results for Surface Water -- BCSP

No surface water sampling stations were established at the BCSP.

4.11.3 Extent of Contamination -- BCSP

Chemical analyses of the soil samples from the three soil borings at the BCSP detected no contamination by semivolatile organics. Metals screen analyses detected low concentrations of heavy metals regulated by drinking water standards in all soil samples. Cadmium (1 to 1.4 mg/kg), nickel (5.6 to 35.8 mg/kg), and zinc (12.4 to 64.7 mg/kg) occurred in concentrations within background ranges as determined for Selfridge ANGB. They also occurred close to the mean concentrations for eastern United States as determined in USGS Professional Paper 1270. No definitive background concentrations could be determined for barium and chromium for Selfridge ANGB because of the scattered distribution of the concentrations. However, all values of barium and chromium were below the mean for these elements for eastern United States soils (USGS Professional Paper 1270). No definitive background values could be determined for arsenic for Selfridge ANGB. Concentrations of arsenic detected at the BCSP (5.9 to 15.9 mg/kg) are above the mean for arsenic (4.8 mg/kg) for eastern United States soils (USGS Professional Paper 1270). However, the concentrations are within the range naturally detected in soils in the eastern United States (<0.1 to 73 mg/kg) and were not among the highest detected concentrations for arsenic from samples at the base. Copper detections were invalidated for the soil samples at this site due to detections of copper in quality control samples, but the concentrations detected in field samples were within natural occurrence ranges. Therefore, all of the metals concentrations are reasonable natural concentrations, and it does not appear that metals are being from the coal leached at elevated concentrations. No evidence of soil contamination was found at the BCSP.

Groundwater samples were collected from the four monitor wells at BCSP. Elevated levels of chloride were detected in monitor

wells 08-129 (6,800 ug/L), 08-126 (2,090 ug/L), and 08-128 (1,170 ug/L). These chloride concentrations may be a result of contamination from an area adjacent to BCSP. Located next to the BCSP within the Roads and Grounds Maintenance Yard is Building 827, a storage area for road salt. The chloride concentrations in monitor wells 08-129 and 08-126 appear to define a chloride plume originating from this location. Based upon the potentiometric surfaces maps (see Figures 4-77 and 4-78) for the BCSP, the chloride plume is moving in the direction of groundwater flow. The concentration of chloride in the groundwater at monitor well 08-128 is likely due to the use of road salt on the paved road located to the west of the BCSP.

Elevated concentrations of TDS were detected in groundwater from monitor wells 08-126 (5,000 ug/L), 08-127 (2,900 ug/L), and 08-129 (12,000 ug/L). These elevated concentrations of TDS may also be related to the storage of road salt at the Roads and Grounds Maintenance Yard. TDS concentrations decrease in the monitor wells in the direction of groundwater flow away from the area of salt storage. The TDS concentration in groundwater was 1,700 ug/L at monitor well 08-128. This concentration of TDS may also be related to the use of road salt near that location.

Several semivolatile organic compounds were detected in the groundwater at the BCSP. The compounds identified and their concentrations were anthracene (<1 ug/L), phenanthrene (<3 ug/L), and pyrene (<2 ug/L) in monitor well 08-128. The compounds are constituents of creosote commonly used to preserve railroad ties. Located near this monitor well is a railroad spur. It is possible that these contaminants originate from the railroad ties and not the BCSP. The direction of groundwater flow (see Figures 4-77 and 4-78) would transport these contaminants toward monitor well 08-128 from the railroad spur. Using the retardation equation and groundwater velocity of 5.39 ft/year (assuming carbon content of 1.0 percent, soil bulk density of 2.1, and an effective porosity of 15 percent), the migration rate for these semivolatile compounds would be approximately 0.03 ft/year.

The semivolatile organic compounds bis(2-ethylhexyl) phthalate and di-n-butyl phthalate, which are common plasticizers, were also detected in the groundwater. The detected concentrations of bis(2-ethylhexyl) phthalate ranged from <2 ug/L in monitor well 08-126 to 15 ug/L in monitor well 08-127. Detected concentrations of di-n-butyl phthalate ranged from <1 ug/L at monitor well 08-128 to <2 ug/L at monitor wells 08-126 and 08-129. Consideration should be given to the possibility that these compounds are laboratory or packaging contaminants, based upon the low concentrations detected in the sample.

No analyte concentrations in soil exceeding applicable standards were detected at BCSP. Concentrations of bis(2-ethylhexyl)

phthalate, di-n-butyl phthalate, cadmium, copper, nickel, zinc, and TDS exceeded the standard for potential international chemical-specific ARARs for several groundwater samples (see Table 4-71). The cadmium concentration in sample 08-129-M001 exceeded most of the standards listed in Table 4-71. Concentrations of copper and nickel exceeded Clean Water Act freshwater toxicity criteria (acute and chronic) and EPA ambient water quality criteria standards, respectively. No surface water samples were collected at BCSP.

4.11.4 Qualitative Risk Assessment -- BCSP

Twenty-three individual chemical species were detected in soil and groundwater samples collected from the BCSP. Surface water samples were not collected at this site. Seven contaminants of concern at BCSP were identified using the EPA indicator chemical selection process. These contaminants of concern include phthalates, PAHs, and metals and are listed in Table 4-72.

The following potential migration pathways for movement of contaminants from the BCSP have been identified:

- Soil --> groundwater
- Soil --> groundwater --> stormwater drainage system --> surface water

Access to this site is not restricted or controlled, and it is estimated that over 100 base personnel are working within 1,000 feet of the site perimeter in adjacent maintenance shop areas on a day-to-day basis.

Metals and phthalates contamination of the groundwater is below criteria levels. However, the allowable concentration established for PAHs as a group by EPA ambient water quality criteria for the protection of human health is zero because of the carcinogenic potential. BCSP is the only site on base identified during this study to contain PAHs in groundwater. Although direct contact with groundwater on base is unlikely because there are no active base water wells, ultimate seepage of this groundwater into the stormwater drainage system is likely to occur and would be discharged into the Clinton River. The relative contribution of PAHs from this site is significant, and the potential contact with downstream Clinton river receptors must be considered as a possible route of exposure.

Soil contamination at this site is subsurface and is limited to nickel and cadmium on the contaminants of concern list. These metals do not represent a direct contact hazard to base personnel. An additional consideration of exposure would be contaminated soils during any remediation activity. It would be necessary to minimize the airborne dust hazard, as both nickel and cadmium are carcinogens by the inhalation route.

Table 4-71

Analyte Concentrations in BCSP Groundwater Exceeding Standards IRP Storage 2, Selfridge ANGB, MI

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Bis(2-ethylhexyl) phthalate		6×10^{-4}	N/A	N/A	N/A	N/A	N/A
08-126-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
08-127-M001	1.5×10^{-3}	X	---	---	---	---	---
08-127-M101	$<4 \times 10^{-3}$	X	---	---	---	---	---
08-128-M001	$<4 \times 10^{-3}$	X	---	---	---	---	---
08-129-M001	$<4 \times 10^{-3}$	X	---	---	---	---	---
Di-n-butyl phthalate		2×10^{-4}	N/A	N/A	N/A	N/A	N/A
08-126-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
08-129-M001	$<2 \times 10^{-3}$	X	---	---	---	---	---
Cadmium		2×10^{-4}	N/A	1×10^{-2}	3.9×10^{-3}	1.1×10^{-3}	1.02×10^{-2}
08-129-M001	1.3×10^{-2}	X	---	X	X	X	X
Copper		5×10^{-3}	N/A	N/A	1.8×10^{-2}	1.2×10^{-2}	N/A
08-128-M001	6×10^{-2}	X	---	---	X	X	---
08-129-M001	2.8×10^{-1}	X	---	---	X	X	---
Nickel		2.5×10^{-2}	N/A	N/A	N/A	N/A	1.34×10^{-2}
08-126-M001	8.8×10^{-2}	X	---	---	---	---	X
08-128-M001	4.7×10^{-2}	X	---	---	---	---	X
08-129-M001	7.3×10^{-2}	X	---	---	---	---	X

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-71
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Bis(2-ethylhexyl) phthalate		N/A	N/A	N/A	N/A	N/A
08-126-M001	<2 x 10^{-3}	---	---	---	---	---
08-127-M001	1.5 x 10^{-3}	---	---	---	---	---
08-127-M101	<4 x 10^{-3}	---	---	---	---	---
08-128-M001	<4 x 10^{-3}	---	---	---	---	---
08-129-M001	<4 x 10^{-3}	---	---	---	---	---
Di-n-butyl phthalate		N/A	N/A	N/A	N/A	N/A
08-126-M001	<2 x 10^{-3}	---	---	---	---	---
08-129-M001	<2 x 10^{-3}	---	---	---	---	---
Cadmium		1.2 x 10^{-2}	1 x 10^{-2}	N/A	5 x 10^{-3}	5 x 10^{-3}
08-129-M001	1.3 x 10^{-2}	X	X	---	X	X
Copper		N/A	N/A	N/A	N/A	N/A
08-128-M001	6 x 10^{-2}	---	---	---	---	---
08-129-M001	2.8 x 10^{-1}	---	---	---	---	---
Nickel		1.54 x 10^{-2}	N/A	N/A	N/A	N/A
08-126-M001	8.8 x 10^{-2}	X	---	---	---	---
08-128-M001	4.7 x 10^{-2}	X	---	---	---	---
08-129-M001	7.3 x 10^{-2}	X	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-71
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	A*	B*	C*	D*	E*	F*
Zinc		3×10^{-2}	N/A	N/A	N/A	N/A	N/A
08-126-M001	5.3×10^{-2}	X	---	---	---	---	---
08 128-M001	9.6×10^{-2}	X	---	---	---	---	---
TDS		2.0×10^{-2}	N/A	N/A	N/A	N/A	N/A
08-126-M021	5.0×10^{3}	X	---	---	---	---	---
08-127-M021	2.9×10^{3}	X	---	---	---	---	---
08-128-M021	1.7×10^{3}	X	---	---	---	---	---
08-128-M121	1.8×10^{3}	X	---	---	---	---	---
08-129-M001	1.2×10^{4}	X	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
A = Great Lakes Water Quality Agreement Objective (mg/L)
B = Proposed RCRA Media Protection Standards for Carcinogens (mg/L)
C = RCRA Maximum Contaminant Level (MCL) (mg/L)
D = Clean Water Act Freshwater Toxicity Criterion-Acute (mg/L)
E = Clean Water Act Freshwater Toxicity Criterion-Chronic (mg/L)
F = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC), Aquatic Organisms, and Drinking Water (mg/L)

Table 4-71
(continued)

Parameter Sample No.	Concentration Detected (mg/L)	G*	H*	I*	J*	K*
Zinc		N/A	N/A	N/A	N/A	N/A
08-126-M001	5.3×10^{-2}	---	---	---	---	---
08-128-M001	9.6×10^{-2}	---	---	---	---	---
TDS		N/A	N/A	N/A	N/A	N/A
08-126-M021	5.0×10^{3}	---	---	---	---	---
08-127-M021	2.9×10^{3}	---	---	---	---	---
08-128-M021	1.7×10^{3}	---	---	---	---	---
08-128-M121	1.8×10^{3}	---	---	---	---	---
08-129-M001	1.2×10^{4}	---	---	---	---	---

X = Standard exceeded.
--- = Standard not exceeded.
N/A = Not applicable.
G = EPA Ambient Water Quality Criterion for Protection of Human Health (WQC) Adjusted for Drinking Water Only (mg/L)
H = Safe Drinking Water Act Maximum Contaminant Level (MCL)(mg/L)
I = Safe Drinking Water Act Maximum Contaminant Level Goal (MCLG)(mg/L)
J = Safe Drinking Water Act Proposed MCL (mg/L)
K = Safe Drinking Water Act Proposed MCLG (mg/L)

Table 4-72

Contaminants of Concern at BCSP, IRP Stage 2, Selfridge ANGB, Michigan

Contaminant	Maximum Concentration Detected in Medium		
	Soil (mg/kg)	Ground-water (mg/L)	Surface Water (mg/L)
Cadmium[a]	0.0014	0.000013	
Nickel[a]	0.035	0.000058	
<u>Phthalates</u>			
Bis(2-ethylhexyl) phthalate		0.015	
Di-n-butyl phthalate		0.002	
<u>PAHs</u>			
Anthracene		0.001[b]	
Phenanthrene		0.003[b]	
Pyrene		0.002[b]	

[a]Known/suspected carcinogen (inhalation route).
[b]Exceeds EPA ambient water quality criteria for the protection of human health.

4.12 PRIORITIZATON OF SITES FOR REMEDIAL ALTERNATIVES (RESULTS OF DPM)

The IRP Stage 2 study identified and evaluated sites where hazardous waste materials were disposed in the past. Previously, as part of the study, a hazard screening system was used to identify sites containing hazardous waste and to rank the sites with respect to their potential environmental hazard (Hazard Assessment Rating Methodology (HARM)). A modification and extension of the HARM system, the Defense Priority Model (DPM), was developed by Oak Ridge National Laboratory. The DPM was developed to permit the use of site-specific monitoring data in the scoring system. This provides for a refinement of priorities for future remedial action. Health and ecological hazards of contaminants identified at a site are assessed in the DPM using toxicological bench marks and bioaccumulation factors that relate the concentrations measured in a medium at the site to concentrations that may be toxic.

Results of the DPM scoring of IRP sites at Selfridge ANGB are presented in Table 4-73. Four categories of subscores are also presented. These show the scores obtained from the assessment of rating pathways, hazards, and receptors within each category. Tables 4-74 to 4-77 present the scores for pathways, contaminant hazards, and receptors used to obtain the site subscores.

During the IRP Phase II Stage 1 study a HARM scoring of the sites at Selfridge ANGB was determined, ranking them in the following order:

1. SWLF
2. FTA-2
3. FTA-1
4. WRMP
5. TCLF
6. NWLF
7. ERMP.

The BCSP was not part of the original IRP investigation and was added prior to the start of the current study at the request of the base personnel. The BCSP was assigned the position of Site 8, although the site was not scored using the HARM.

Based upon the DPM scoring of sites at Selfridge ANGB during the current investigation, a new order of rank was determined. The revised site ranking as determined from the DPM scoring is:

1. SWLF
2. ERMP
3. WRMP
4. NWLF
5. FTA-2
6. TCLF
7. BCSP
8. FTA-1

Table 4-73

Defense Priority Model Site Scores, IRP Stage 2, Selfridge ANGB, MI

Site Name	Surface Water/ Human Health Subscore	Surface Water/ Ecological Subscore	Groundwater/ Human Health Subscore	Groundwater/ Ecological Subscore	Site Score
SWLF	52	23	5	57	38
FTA-2	48	23	4	21	32
FTA-1	9	2	5	7	7
WRMP	56	9	6	10	36
TCLF	28	19	6	38	22
NWLF	44	37	6	29	32
ERMP	56	19	6	12	37
BCSP	6	9	6	38	13

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Table 4-74

Defense Priority Model
Surface Water/Human Health Subscores,
IRP Stage 2, Selfridge ANGB, MI

Site Name	Pathway Score	Contaminant Hazard Score	Receptor Score	Overall Subscore
SWLF	100	100	52	52
FTA-2	100	100	48	48
FTA-1	50	33	52	9
WRMP	100	100	56	56
TCLF	50	100	56	28
NWLF	80	100	56	44
ERMP	100	100	56	56
BCSP	48	22	56	6

Table 4-75

Defense Priority Model
Surface Water/Ecological Subscores,
IRP Stage 2, Selfridge ANGB, MI

Site Name	Pathway Score	Contaminant Hazard Score	Receptor Score	Overall Subscore
SWLF	100	83	28	23
FTA-2	100	83	28	23
FTA-1	50	17	28	2
WRMP	100	17	56	9
TCLF	50	67	56	19
NWLF	80	83	56	37
ERMP	100	33	56	19
BCSP	48	67	28	9

Table 4-76

Defense Priority Model
Groundwater/Human Health Subscores,
IRP Stage 2, Selfridge ANGB, MI

Site Name	Pathway Score	Contaminant Hazard Score	Receptor Score	Overall Subscore
SWLF	100	100	5	5
FTA-2	100	100	4	4
FTA-1	100	100	5	5
WRMP	100	100	6	6
TCLF	100	100	6	6
NWLF	100	100	6	6
ERMP	100	100	6	6
BCSP	100	100	6	6

Table 4-77

Defense Priority Model
Groundwater/Ecological Subscores,
IRP Stage 2, Selfridge ANGB, MI

Site Name	Pathway Score	Contaminant Hazard Score	Receptor Score	Overall Subscore
SWLF	100	100	57	57
FTA-2	100	50	43	21
FTA-1	100	50	14	7
WRMP	100	17	57	10
TCLF	100	67	57	38
NWLF	100	67	43	29
ERMP	100	17	71	12
BCSP	100	67	57	38

The DPM score sheets for each IRP site and a list of comments used to justify the scoring of each question are presented in Appendix P. Only the analytical results for groundwater and surface water samples collected during this study were used in the DPM scoring. Information on contaminants detected in soils, groundwater, and surface water samples collected during the IRP Phase II Stage 1 study was not used in the DPM scoring. This was done so that only the most recent analytical results were used in the evaluation and ranking of sites, reflecting the present degree of contamination at each IRP site. Analytical data obtained from soil samples during this study also were not used to determine DPM scores. This is because the DPM system only assesses the hazards associated with the groundwater and surface water pathways.

The basis of reasoning for the determination of each number entry on the site scoring sheet is presented in Appendix P. A common method of scoring, based upon similar assumptions and reasoning for the base and each IRP site, was used. Evaluation of a DPM scoring question was made from the guidance provided in the DPM scoring document and a knowledge of site conditions and the local settings of the IRP sites.

SECTION 5

PRELIMINARY FEASIBILITY STUDY

This section presents the study process and the results of the preliminary feasibility study performed for the eight IRP sites at Selfridge ANGB as part of IRP Stage 2 activities. The preliminary feasibility study includes four steps:

- Identification of available remedial technologies.
- Screening of technologies for applicability to site conditions.
- Assembly of operable units addressing various contaminated media.
- Preliminary assembly of remedial action alternatives.

5.1 IDENTIFICATION OF TECHNOLOGIES

As documented in Section 4, the eight IRP sites at Selfridge ANGB involve a varied suite of contaminants in a variety of environmental settings. The result of this diversity is that no single technology is likely to provide the best cleanup for all sites at the base. Instead, the best cleanup for the base as a whole is likely to result from the application of a group of cleanup technologies systematically chosen so that each site receives appropriate remedial action.

This subsection develops a structured list of the major cleanup technologies available for remediation of each of the IRP sites at Selfridge ANGB and provides the foundation upon which the systematic selection is based. The identification of remedial technologies begins by identifying general response actions. It concludes with the listing of specific remedial technologies within each general response action. This listing also considers the applicability of the technologies to remediation of the three contaminated media at Selfridge ANGB -- soil, groundwater, and surface water. Table 5-1 provides a tabular summary of the technologies considered for Selfridge ANGB.

5.1.1 General Response Actions

The broadest groupings of remedial technologies are general response actions. These actions fall into six categories:

- No Action.
- Institutional Control.
- Containment.

Table 5-1

Identification of Remedial Technologies, IRP Stage 2, Selfridge ANGB, MI

General Response Action	Identified Technology	Medium SL	GW	SW
No action	No action	X	X	X
Institutional control	Monitoring	NA	X	X
	Access restrictions	X	X	X
	Deed restrictions	X	X	X
Containment	Capping	NA	NA	X
	Vertical barriers	NA	X	NA
	Bottom sealing	NA	X	NA
	Sewer infiltration control	NA	X	NA
Collection/removal	Surface water interception	NA	NA	X
	Soil excavation	X	NA	NA
	Groundwater extraction	NA	X	NA
Treatment	In situ biodegradation	X	X	NA
	In situ physical treatment			
	In situ volatilization	X	NA	NA
	In situ flushing	X	X	NA
	In situ chemical treatment	X	X	NA
	In situ thermal treatment			
	In situ vitrification	X	NA	NA
	In situ RF heating	X	NA	NA

SL - Soil
GW - Groundwater
SW - Surface water
X - Technology identified as applicable to remediation of the contaminated medium.
NA - Technology not applicable.

Table 5-1
(continued)

General Response Action	Identified Technology	Medium SL	GW	SW
Treatment (continued)	Out-of-ground land farm treatment	X	NA	NA
	Out-of-ground physical treatment			
	Solidification	X	NA	NA
	Out-of-ground chemical treatment			
	Surface water treatment	NA	NA	X
	Stabilization	X	NA	NA
	Chemical extraction	X	NA	NA
	Groundwater treatment	NA	X	NA
	Out-of ground thermal treatment			
	Low-temperature thermal treatment	X	NA	NA
	Rotary kiln incineration	X	NA	NA
Disposal	In situ disposal			
	Untreated soil	X	NA	NA
	Treated soil	X	NA	NA
	Untreated water	NA	X	NA
	Treated water	NA	X	NA
	On-site disposal			
	Untreated soil	X	NA	NA
	Treated soil	X	NA	NA
	Untreated water	NA	X	X
	Treated water	NA	X	X
	Treatment residuals	X	X	X
	Off-site disposal			
	Untreated soil	X	NA	NA
	Treated soil	X	NA	NA
	Treated water	NA	X	X
	Treatment residuals	X	X	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Technology identified as applicable to remediation of the contaminated medium.
NA - Technology not applicable.

- Collection/Removal.
- Treatment.
- Disposal.

The no action category involves complete inaction at a given site. It allows conditions and processes currently occurring at the site to continue.

Institutional control alters the interaction of people with the contaminated medium without addressing the contamination itself.

Containment limits the spatial distribution of the contamination without altering the chemistry of the contaminant.

Collection/Removal alters the position of the contamination.

Treatment alters the chemistry of the contaminants to render them less harmful.

Disposal determines the ultimate location of the contaminant or decontaminated residues.

5.1.2 No Action Technologies

To undertake no action is to refrain from intervening in the fate and transport of contaminants at a site. Under the no action technology any endangerment to the public health, welfare, and the environment remains near its present levels or changes only gradually (increase or decrease). The SOW requires that the no action technology be considered.

The no action technology does not necessarily perpetuate the status quo because natural processes may be transforming a site. In this context the no action alternative is known as passive remediation. Passive remediation recognizes the beneficial effects of natural biodegradation, volatilization, photolysis, leaching, and adsorption. The no action technology applies to soil, groundwater, and surface water.

5.1.3 Institutional Control Technologies

5.1.3.1 Monitoring

Monitoring involves no substantial action on contaminated media, but it does provide information about the status of pollutants. In situations where no other action is taken, monitoring can serve not only to document passive remediation, but also to provide early warning in the event that passive remediation fails to adequately protect public health or the environment. Monitoring may also be needed in situations where containment, collection/removal, or treatment actions are taken. Its purpose in these situations would be to document the effectiveness of the remedial actions. Monitoring applies to groundwater and surface water.

5.1.3.2 Access Restrictions

Access restrictions limit the contact of people with contaminants by restricting the free movement of individuals. Fences, signs, standing orders, and regulations can be elements of a program of access restrictions. Access restrictions apply to soil, groundwater, and surface water.

5.1.3.3 Deed Restrictions

Deed restrictions involve covenants against particular uses of land which would cause or increase environmental risk. Deed restrictions would be needed if Selfridge ANGB real estate were ever sold to private parties while environmental contaminants were still present. Deed restrictions apply to soil, groundwater, and surface water.

5.1.4 Containment Technologies

5.1.4.1 Capping

Capping entails placing a horizontal, impermeable cover over an area of surficial or belowground contamination. This type of capping physically isolates the contamination from the aboveground environment by the cap's mere presence, preventing direct contact by individuals or fauna. The cap's impermeability also reduces the quantity of infiltrating precipitation that passes through areas of contamination and so reduces generation of leachate.

The cap may be constructed of almost any impervious engineering material. Hazardous waste sites typically employ thick layers of clay or a sequence of plastic membranes and selected soils. Asphalt and portland cement/concrete can also be used for caps, and the resultant cap can serve as a parking lot or storage area. Capping prevents uncontaminated surface water from coming in contact with contaminated soil and groundwater. Capping applies to surface water.

5.1.4.2 Vertical Barriers

Vertical barriers are low-permeability walls that are built around areas of contamination. The presence of the walls inhibits groundwater flow and contaminant transport. If placed downgradient of contamination, a vertical barrier captures contaminants before they can migrate away. If placed upgradient of contamination, a vertical barrier minimizes the interaction of clean groundwater with waste, thereby reducing leachate generation and ongoing groundwater contamination.

Vertical barriers are usually composed of soil-bentonite slurries, cement-bentonite slurries, grout curtains, or sheet piling. Vertical barriers apply to groundwater.

5.1.4.3 Bottom Sealing

Bottom sealing entails placing a horizontal, impermeable barrier within the subsurface beneath an area of contamination. Bottom sealing isolates the waste and any leachate within it from underlying groundwater. The two primary methods of bottom sealing are block displacement and injection grouting. To be effective, bottom sealing must be used in conjunction with vertical barriers. Bottom sealing applies to groundwater.

5.1.4.4 Sewer Infiltration Control

Contaminated groundwater that would otherwise have a long travel time to an exposure point and thus be isolated from the environment may enter the environment more quickly by infiltration into leaky sewers. As discussed in Section 4, there is evidence that groundwater is discharging to the stormwater drainage system at Selfridge ANGB. Once contaminated groundwater enters these sewers it can be transported rapidly to the pump stations and discharged where people, flora, and fauna may then be exposed to the pollutants. Sewer infiltration control involves replacing or repairing leaky sewers that admit contaminated groundwater or landfill leachate. By reducing the likelihood that contaminants can move into the sewer system, sewer infiltration control enhances containment. Sewer infiltration control applies to groundwater.

5.1.5 Collection/Removal Technologies

5.1.5.1 Surface Water Interception

Surface water interception involves manipulating surface water flow to direct the runoff path. Surface water interception is accomplished by site grading, berms, troughs, ditches, and storm sewers. Once surface water is intercepted and stored it may be treated prior to being discharged.

The surface water technologies considered at Selfridge ANGB include hydraulic structures designed to control contaminated surface water before it can move away from a site. For example, a surface water technology that would control contaminated water is runoff detention in a lined pond. A detention system holds potentially contaminated runoff or other liquid discharges (e.g., fuel spills), preventing rapid migration by way of stormwater sewers and allowing treatment prior to discharge. Surface water interception applies to surface water.

5.1.5.2 Soil Excavation

Soil excavation involves earth removal with conventional earth-moving equipment. Soil excavation may be followed by out-of-ground treatment and/or disposal. Soil excavation applies to soil.

5.1.5.3 Groundwater Extraction

Groundwater extraction involves placing wells or infiltration trenches near an area of contamination. Groundwater extraction conducted upgradient of contamination can prevent clean groundwater from contacting contaminants. Extraction conducted downgradient from contaminant sources can extract the contaminant plume for subsequent out-of-ground treatment and/or disposal. Groundwater extraction applies to groundwater.

5.1.6 Treatment Technologies

5.1.6.1 In Situ (Enhanced) Biodegradation

In situ (enhanced) biodegradation involves the biological transformation of organic contaminants into less harmful compounds. Most petroleum hydrocarbons can be degraded by microbes to carbon dioxide and water. In situ (enhanced) biodegradation installations vary considerably from site to site, but they typically contain provisions for microorganism, nutrient, and oxygen injection. Major ancillary equipment may include wells and barriers to control local groundwater flow to isolate and facilitate microorganism activity. In situ (enhanced) biodegradation applies to soil and groundwater.

5.1.6.2 In Situ Physical Treatment

In Situ Volatilization

In situ volatilization employs forced air drafts through in-place unsaturated soil to induce volatilization of volatile organics. Blowers, vacuums, or a combination of the two induce the forced air draft. Slotted vent pipes inserted vertically into the contaminated soil mass deliver and retrieve the air. Typical major ancillary equipment for in situ volatilization includes an air preheater and a package treatment unit for discharged air. In situ volatilization applies to soil.

In Situ Flushing

In situ flushing employs injection of water into contaminated, in-place soil and subsequent extraction of the resultant water-contaminant mixture. The extracted liquid can be treated and/or disposed. In some cases the effluent water may be returned to the head end of the flushing process instead of being disposed. In situ flushing applies to soil and groundwater.

5.1.6.3 In Situ Chemical Treatment

In situ chemical treatment is similar to in situ flushing, but differs by the addition of surfactants to the injection water to encourage hydrophobic compounds to elute. The addition of surfactants often improves cleanup of petroleum products in particular because oils do not mix well with ordinary water.

Water can be separated from the petroleum-laden surfactants for treatment and/or disposal at the effluent end of the process. There are currently no economical means to regenerate the surfactant and recover the petroleum, so the petroleum-laden surfactants must be disposed. In situ chemical treatment would also remove soluble inorganic contaminants. In situ chemical treatment applies to soil and groundwater.

5.1.6.4 In Situ Thermal Treatment

In Situ Vitrification

In situ vitrification is an experimental technology for cleanup of waste in soil that was first developed for radioactive waste. The process involves placing electrodes into the soil, applying an electric current to the electrodes, and melting the soil between the electrodes. The melted soil is allowed to cool and becomes a hard, glassy mass. The contaminants are rendered harmless by pyrolosis, by incorporation into the vitrified mass, and by volatilization. In situ vitrification applies to soil.

In Situ RF Heating

In situ RF (microwave radio frequency) heating is an experimental technology for removing volatile organics from soil. It involves placing electrodes into the contaminated zone and using radio-frequency electromagnetic energy to heat the soil by molecular agitation. Heating of the soil causes volatile organics to enter the gas phase, which can then be collected using a fume hood.

In situ RF heating was used successfully to clean up a fire training area in a field test at Volk Field Air National Guard Base at Camp Douglas, Wisconsin. In situ RF heating applies to soil.

5.1.6.5 Out-of-Ground Land Farm Treatment

Land farm treatment generally involves excavating contaminated soil and spreading it on the ground surface so that natural processes can destroy the contaminants. Soil affected to a depth of less than 5 feet may sometimes be treated in situ.

The natural destructive processes active in land farm treatment include volatilization, biodegradation, and photolysis. It has been widely used in the petroleum industry for petroleum-contaminated soil. Land farm treatment may be performed on site or off site at a commercial treatment area. On-site land farm treatment at Selfridge ANGB would require the purchase of specialized equipment and earth work to construct the facility. On-site land farm treatment would also require intensive operation and monitoring attention. Land farm treatment applies to soil.

5.1.6.6 Out-of-Ground Physical Treatment

The sole out-of-ground physical treatment applicable to the Selfridge ANGB sites is solidification. It involves mixing the contaminated soil with a reagent that reduces the free water content of the waste. Most applications of the technology have been with inorganic waste, but organic waste has been successfully solidified. Solidification may take place on site using earthmoving equipment for mixing or off site using pugmill mixers at a commercial facility. Solidification applies to soil.

5.1.6.7 Out-of-Ground Chemical Treatment

Surface Water Treatment

Surface water treatment involves the removal of objectionable constituents from water prior to disposal. Surface water treatment often requires surface water storage because rainfall runoff quantities fluctuate dramatically over time. Surface water can be treated on site using temporary/mobile treatment units, on site at a central treatment facility after transport by truck or piping, or off site at a commercial or publicly owned treatment works after transport by truck or sewer system. Treatment processes may include equalization, pH adjustment, nutrient adjustment, flocculation, settling/clarification, biodegradation, air stripping, oil-water separation, and activated carbon adsorption. Surface water treatment applies to surface water.

Stabilization

Stabilization is similar to solidification, but the contaminants are not only physically trapped in the stabilized mass, they are also chemically bound to the treated soil matrix. Stabilization has been used primarily for treating inorganic contaminants. In stabilization the actual chemistry of the binding process must be carefully assessed, particularly as to potential chemical interferences that would result in the presence of free liquids or prevent the stabilized mass from obtaining the desired physical properties. Stabilization applies to soil.

Chemical Extraction

Chemical extraction resembles the in situ chemical treatment technology discussed previously. The major differences are that the soil is removed from the ground and the washing action occurs in a machine. Isolation of the soil in the machine allows use of a greater range of solvents. Chemical extraction can take place on site in a temporary/mobile unit, on site at a central treatment facility, or off site at a commercial treatment facility. Chemical extraction applies to soils.

Groundwater Treatment

Groundwater treatment involves the removal of objectionable constituents from water prior to disposal. Groundwater can be treated on site using temporary/mobile treatment units, on site at a central treatment facility after transport by truck or piping, or off site at a commercial or publicly owned treatment works after transport by truck or sewer system. Treatment processes may include equalization, pH adjustment, nutrient adjustment, flocculation, settling/clarification, biodegradation, air stripping, oil-water separation, and activated carbon adsorption. Groundwater treatment applies to groundwater.

5.1.6.8 Out-of-Ground Thermal Treatment

Low-Temperature Thermal Treatment

Low-temperature thermal treatment involves the placement of excavated soil in a heated treatment chamber that warms the soil so that water vapor and organics are released. A sweep gas carries the volatilized materials through a secondary treatment train that can include provisions for product recovery. Low-temperature thermal treatment can be performed on site using a temporary/mobile unit or off site at a stationary installation. Low-temperature thermal treatment applies to soil.

Rotary Kiln Incineration

Rotary kiln incinerators burn excavated soil and soil contaminants in a chamber at temperatures as high as 2,500°C. Destruction efficiencies of 99.99 percent are possible. Petroleum-contaminated soils are particularly well suited to incineration because petroleum provides some of the required fuel. Rotary kiln incineration may take place on site using relatively small temporary/transportable units or off site at larger commercial facilities. Rotary kiln incineration applies to soil.

5.1.7 Disposal Technologies

5.1.7.1 In Situ Disposal

In situ disposal can occur as a result of using institutional controls, containment, or in situ treatment technologies. With institutional controls and containment, untreated soil and groundwater are simply left in place. With in situ treatment, treated soil (including other solid treatment residues) and groundwater remain in place following treatment. Special care is needed with in situ disposal to be sure that the wastes are adequately monitored, contained, or treated due to the inherent difficulty of inspecting and verifying the completeness or integrity of an in situ disposal unit. In situ disposal applies to untreated and treated soil and to untreated and treated groundwater.

5.1.7.2 On-Site Disposal

On-site disposal can occur as a result of using collection/removal or out-of-ground treatment technologies. If collection/removal technologies are not followed by treatment technologies, the surface water, soil, or groundwater disposed will be untreated. Examples of this situation include direct discharge of runoff from a fire training area, construction of a new landfill for excavated soils, and direct discharge of recovered groundwater. On-site disposal of treated materials would occur for out-of-ground treatment performed on site. Examples of on site disposal following treatment include discharge of treated surface water to storm sewers, placement of treated soil back in its original excavation, and discharge of treated groundwater to storm sewers or by reinjection. On-site disposal of other treatment residues, such as incinerator ash or water treatment sludges, is also possible at Selfridge ANGB. On-site disposal applies to untreated and treated soil, untreated and treated groundwater, untreated and treated surface water, and other treatment residues.

5.1.7.3 Off-Site Disposal

Off-site disposal can also occur as a result of using collection/removal and out-of-ground treatment technologies. If collection/removal technologies are followed by off-site treatment technologies, off-site disposal of treated soil, water, and residues is more likely to occur than on-site disposal. Examples of this situation include use of treated soil for daily cover at a landfill, discharge of treated water from a commercial or publicly owned treatment works, and landfilling of incinerator ash or wastewater treatment sludge. Off-site disposal of untreated material is plausible only for soils and treatment residues, and this would likely involve landfilling. Off-site disposal applies to untreated and treated soil and treated water and treatment residues from off- or on-site treatment.

5.2 SCREENING OF TECHNOLOGIES

This subsection presents a screening of the available technologies developed in the preceding subsection to determine the potential applicability of each technology to remediation at each of the eight IRP sites at Selfridge ANGB. The evaluation uses four screening criteria:

- Technical feasibility.
- Implementability.
- Effectiveness.
- Cost.

Technical feasibility is a measure of whether the technology is proven and reliable. Implementability measures the ability to implement a technology with regard to nontechnical issues such

as Federal, state, and local regulatory requirements; and availability of equipment, skilled workers, etc. Effectiveness is a measure of how well a technology reduces contamination and protects human health and the environment. Cost at the screening stage simply refers to relative capital and operations and maintenance (O&M) estimates and not detailed costs.

In order to pass the screening process at a given site, a technology must perform reasonably well on the first three criteria. Substandard performance on even one criterion among the first three may remove the technology from further consideration at a given site. Cost is only used to discriminate among technologies that provide similar results. Technologies that destroy wastes or reduce the mobility, toxicity, or volume of wastes are not eliminated on the basis of cost alone. Table 5-2 summarizes the results of technology screening for each of the eight IRP sites at Selfridge ANGB.

5.2.1 No Action Technologies

The no action (passive remediation) technology is technically feasible at all the Selfridge ANGB sites because it requires no design or operation. The no action technology is easily implemented because there is nothing to implement. The no action technology may be effective at sites that pose no significant risks to public health or the environment. There are no capital and O&M costs associated with this technology.

No action truly means "no action." The no action technology is clearly distinct from institutional control, even a passive one such as monitoring.

Conclusion: The no action technology passes screening because it may be appropriate at sites having relatively low levels of environmental contaminants and because the no action technology needs to be carried through further evaluation to serve as a basis for comparison with other alternatives.

5.2.2 Institutional Control Technologies

5.2.2.1 Monitoring

Monitoring is technically feasible and implementable at all Selfridge ANGB sites, as demonstrated by the existing network of monitoring devices at the base. Monitoring may be an effective technology at sites that are not expected to threaten public health or the environment and is definitely effective in conjunction with a remediation technology. Cost poses no problem because the present monitoring program demonstrates that monitoring can occur at reasonable cost.

Conclusion: Monitoring passes screening at all sites.

Table 5-2

Screening of Remedial Technologies, IRP Stage 2, Selfridge ANGB, MI

General Response Action	Identified Technology	Medium			Site								
		SL	GW	SW	SWLF	FTA-2	FTA-1	WRMP	TCLF	NWLF	ERMP	BCSP
No action	No action	0	0	0	X	X	X	X	X	X	X	X
Institutional control	Monitoring	NA	0	0	X	X	X	X	X	X	X	X
	Access restrictions	0	0	0	X	X	X	X	X	X	X	X
	Deed restrictions	0	0	0	X	X	X	X	X	X	X	X
Containment	Capping	NA	NA	0	X	--	X	--	X	X	--	--
	Vertical barriers	NA	0	NA	X	--	--	--	X	X	--	--
	Bottom sealing	NA	0	NA	--	--	--	--	--	--	--	--
	Sewer infiltration control	NA	0	NA	X	X	--	X	X	X	X	--
Collection/removal	Surface water interception	NA	NA	0	X	X	--	X	X	X	X	X
	Soil excavation	0	NA	NA	--	X	X	X	--	--	X	X
	Groundwater extraction	NA	0	NA	X	X	X	X	X	X	X	X
Treatment	In situ biodegradation	0	0	NA	--	--	--	--	--	--	--	--
	In situ physical treatment											
	In situ volatilization	0	NA	NA	--	--	--	--	--	--	--	--
	In situ flushing	0	0	NA	--	--	--	--	--	--	--	--
	In situ chemical treatment	0	0	NA	--	--	X	--	--	--	--	--
	In situ thermal treatment											
	In situ vitrification	0	0	NA	--	--	--	--	--	--	--	--
	In situ RF heating	0	0	NA	--	X	X	--	--	--	--	--

SL = Soil
GW = Groundwater
SW = Surface water
NA = Not applicable because technology does not perform well enough or is not relevant.
0 = Technology performed reasonably well or better.
-- = Technology does not pass the screening process for this site.
X = Technology passes the screening process for this site.

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Table 5-2
(continued)

General Response Action	Identified Technology	Medium SL	Medium GW	Medium SW	Site SWLF	Site FTA-2	Site FTA-1	Site WRMP	Site TCLF	Site NWLF	Site ERMP	Site BCSP
Treatment (continued)	Out-of-ground land farm treatment	0	NA	NA	--	--	--	--	--	--	--	--
	Out-of-ground physical treatment											
	Solidification	0	NA	NA	--	--	--	--	--	--	--	--
	Out-of-ground chemical treatment											
	Surface water treatment	NA	NA	0	X	X	--	X	X	X	X	X
	Stabilization	0	NA	NA	--	--	--	--	--	--	--	X
	Chemical extraction	0	NA	NA	--	--	--	--	--	--	--	--
	Groundwater treatment	NA	0	NA	X	X	X	X	X	X	X	--
	Out-of-ground thermal treatment											
	Low-temperature thermal treatment	0	NA	NA	--	X	X	X	--	--	X	--
	Rotary kiln incineration	0	NA	NA	--	X	X	--	--	--	--	--
Disposal	In situ disposal											
	Untreated soil	0	NA	NA	X	X	X	X	X	X	X	X
	Treated soil	0	NA	NA	--	X	X	--	--	--	--	--
	Untreated water	NA	0	NA	X	X	X	X	X	X	X	X
	Treated water	NA	0	NA	--	X	X	--	--	--	--	--
	On-site disposal											
	Untreated soil	0	NA	NA	--	--	--	--	--	--	--	--
	Treated soil	0	NA	NA	--	X	X	X	--	--	X	X
	Untreated water	NA	0	0	--	--	--	--	--	--	--	--
	Treated water	NA	0	0	X	X	X	X	X	X	X	X
	Treatment residuals	0	0	0	--	X	X	--	--	--	--	--
	Off-site disposal											
	Untreated soil	0	NA	NA	--	--	--	--	--	--	--	--
	Treated soil	0	NA	NA	--	X	X	X	--	--	X	X
	Treated water	NA	0	0	X	X	X	X	X	X	X	X
	Treatment residuals	0	0	0	X	X	X	X	X	X	X	X

SL = Soil
GW = Groundwater
SW = Surface water
NA = Not applicable because technology does not perform well enough or is not relevant.
0 = Technology performed reasonably well or better.
-- = Technology does not pass the screening process for this site.
X = Technology passes the screening process for this site.

5.2.2.2 Access Restrictions

Access restrictions are technically feasible at all sites because little or no technology is required to implement them. They are implementable particularly because a military base has a great degree of control over the movement of people. They are effective particularly with respect to their protection of people. There is relatively little cost associated with this technology.

Conclusion: Access restrictions pass screening at all sites.

5.2.2.3 Deed Restrictions

Deed restrictions are technically feasible at all sites because no technology is required to implement them. They are implementable because deed restrictions are frequently an element of real estate transactions. They are effective particularly with respect to their protection of people because they are binding on all future land owners. The cost of deed restrictions is feasible because they are relatively inexpensive compared to other general response actions.

Conclusion: Deed restrictions pass screening at all sites.

5.2.3 Containment Technologies

5.2.3.1 Capping

Capping is currently technically feasible at all the sites because the technology for capping is well established. Caps are readily implemented because the skills and equipment needed to build them are universally available. Caps are effective because they reduce infiltration and interpose a physical barrier between people and the contaminated soil.

There is generally a relatively low cost associated with cap installation and maintenance. Their relative unit cost is particularly low at large sites such as the landfills and FTA-1.

Conclusion: Capping passes screening at the large sites and at low-risk sites.

5.2.3.2 Vertical Barriers

Vertical barriers are currently technically feasible at all sites because the technology for vertical barriers is well established. Vertical barriers are readily implementable because the machines and manpower needed to build them are universally available. Vertical barriers are effective because they interpose a physical barrier between clean groundwater and contaminated groundwater. Vertical barriers are a generally feasible, relatively low-cost technology. Their unit cost is also lower at larger sites.

Conclusion: Vertical barriers pass screening at large sites such as landfills.

5.2.3.3 Bottom Sealing

Bottom sealing is not technically feasible at any of the sites because bottom sealing of in-place waste deposits is still in the developmental stage. A bottom seal that would contain waste with confidence is currently not available.

Conclusion: Bottom sealing does not pass screening at any of the sites due to a lack of industry experience and the inability to confidently contain the waste.

5.2.3.4 Sewer Infiltration Control

Sewer infiltration control is technically feasible for elimination of infiltration of contaminated groundwater into stormwater or sanitary sewers. Sewer infiltration control is easy to implement. The technology may involve the open-cut replacement of sewers or slip lining of existing sewers, but in all cases experienced contractors are available. The technology is effective because it interdicts a contaminant pathway that can swiftly carry contamination from the groundwater to surface water. Sewer pipe replacement or repair is relatively inexpensive compared to other general response actions.

Conclusion: Sewer infiltration control passes screening at all sites.

5.2.4 Collection/Removal Technologies

5.2.4.1 Surface Water Interception

Surface water interception is technically feasible at any of the sites at Selfridge ANGB. The technology involves ordinary urban hydraulic structures: pavements, berms, curbs, gutters, storm inlets, ditches, storm sewers, detention basins, and pump houses. The technology is easily implemented because ordinary construction contractors can build or assemble the structures. The technology is effective because it can capture contaminants before they enter the environment. A fuel spill, for instance, need not cause environmental problems as long as the proper surface water interception structures are present to capture contaminated runoff. Surface water interception has a relatively low cost.

Conclusion: Surface water interception passes screening at all sites having a surface water pathway. Surficial interception could be applied to sites having actual or potential contamination of water in ponds, seeps, or ditches. These sites are SWLF, FTA-2, WRMP, NWLF, and BSCP. Interception within the stormwater drainage system could be applied to sites having actual or potential contamination within the stormwater system,

including sites with contaminated groundwater. These sites are SWLF, FTA-2, WRMP, TCLF, NWLF, ERMP, and BCSP.

5.2.4.2 Soil Excavation

Soil excavation is technically feasible at any of the sites at Selfridge ANGB. Implementation is feasible at any of the sites because many earthmoving contractors specialize in precisely this activity. Implementation may be hampered by the presence of petroleum products that would necessitate monitoring to maintain a safe workplace. Implementation at extremely large sites, such as the Selfridge ANGB landfills, would be difficult and time consuming due to the heterogeneous nature of the wastes. Excavation is almost always effective as long as the contaminant mass is well defined. Soil excavation generally has a moderate unit cost, which makes it most suitable for small sites.

Conclusion: Soil excavation passes screening at the fire training areas, the ramps, and the coal storage pile. It does not pass screening at the landfills because of the volumes of material involved and the physical and chemical variability of the wastes that would require treatment or disposal.

5.2.4.3 Groundwater Extraction

Groundwater extraction is technically feasible at any of the sites at Selfridge ANGB. Analysis (possibly involving mathematical modeling) of hydrogeologic factors provides the requisite information for design of an extraction system. Implementation is not a problem because contractors that specialize in drilling water wells or constructing subsurface drains are common. Groundwater extraction is effective at all sites because it removes contamination from the environment. Groundwater extraction is expected to be economically feasible at all sites because its cost is generally low.

Conclusion: Groundwater extraction passes screening at all sites.

5.2.5 Treatment Technologies

5.2.5.1 In Situ Biodegradation

In situ biodegradation is not technically feasible. The fine-grained soil at Selfridge ANGB makes hydraulic control of the contaminated areas difficult to achieve. The soil also makes successful control of the biological maintenance factors difficult. Under favorable circumstances in situ biodegradation is effective, and a number of successful case studies document reductions in subsurface contamination. In situ biodegradation is not easily implementable at Selfridge ANGB due to the proximity of the sites to active runways and fire training facilities. The aboveground structures associated with the process

could pose a safety hazard for airplanes and vehicles. The technology is economically feasible at the larger sites such as the ramps, but less so at smaller sites because fixed costs for in situ biodegradation facilities are typically large. Direct elimination of contaminant sources prior to biodegradation can enhance the economic feasibility of the process.

Conclusion: In situ biodegradation does not pass screening at any of the sites because of the fine-grained soil at Selfridge ANGB and because of potential interference with base operations.

5.2.5.2 In Situ Physical Treatment

In Situ Volatilization

In situ volatilization is technically feasible at any of the Selfridge ANGB sites where the contamination consists of petroleum hydrocarbons; specifically, the ramps and the fire training areas. The high clay content of the soil is, however, expected to reduce volatilization efficiency and, therefore, lengthen the time required for cleanup. In situ volatilization is not readily implemented near runways (in locations like the ramps) because aboveground structures are required for the duration of the operation. Similarly, the ongoing use of FTA-2 precludes the use of in situ volatilization at FTA-2. The technology is effective because it removes the source of contamination. The technology is economically effective because of its relatively low cost.

Conclusion: In situ volatilization does not pass screening at any of the sites due to soil characterization and/or proximity to runways.

In Situ Flushing

In situ flushing is not technically feasible at the Selfridge ANGB sites. The landfills are so large as to make the necessary hydraulic control difficult. The hydrophobic properties of hydrocarbons indicate that leaching with ordinary water is unlikely to work at the petroleum-contaminated sites.

Conclusion: In situ flushing does not pass screening at any of the sites because it is not technically feasible.

5.2.5.3 In Situ Chemical Treatment

In situ chemical treatment is technically feasible at the hydrocarbons-contaminated sites; however, the landfills are too large to easily allow the necessary hydraulic control. The hydrophobic properties of the petroleum hydrocarbons do not prevent in situ chemical treatment because the surfactants introduced to the system result in emulsification of oily materials. In situ chemical treatment is implementable because the

injection, withdrawal, and treatment elements of the technology are ordinary activities when attempted individually. From a practical standpoint, however, in situ chemical treatment would disrupt fire training exercises at FTA-2 and would also disrupt flight operations on the ramps. Costs are comparable to other in situ treatment technologies. In situ chemical treatment is effective because it directly addresses the contaminant source.

Conclusion: In situ chemical treatment passes screening only at FTA-1 because it is small enough to be controled hydraulically and because it is away from areas of greater activity.

5.2.5.4 In Situ Thermal Treatment

In Situ Vitrification

In situ vitrification may be technically feasible at the ramps and fire training areas, but its application at landfills is questionable due to the heterogeneity of the wastes. The technology is currently only demonstrated for use at radioactive sites, but process modifications create the possibility that in situ vitrification may work at sites contaminated with petroleum hydrocarbons. In situ vitrification is not readily implementable because there are few vendors and few trained people to run it. The devices are effective because they destroy the contaminants through pyrolysis. Any organics that do not pyrolyze should spontaneously ignite, be drawn into the gas collection hood, or be immobilized in the crystals of the meltdown mass. The technology is economically feasible because it has a unit cost comparable to destruction technologies such as incineration.

Conclusion: In situ vitrification does not pass screening at any of the sites because results from full-scale demonstration projects with hazardous waste are not yet available.

In Situ RF Heating

In situ RF heating is technically feasible at the fire training areas. Fire training areas are the only type of facility where this technology is demonstrated to work. RF heating is implementable because the Air Force has access to the specialized heating devices required. RF heating is effective because it permanently removes contaminants from the soil. The technology is economically feasible because it has only a moderate unit cost. Use of RF heating should be compatible with ongoing use of FTA-2 because RF heating requires less than 1 month to execute.

Conclusion: In situ RF heating passes screening at the fire training areas because RF heating has worked at similar sites.

5.2.5.5 Out-of-Ground Land Farm Treatment

Land farming is technically feasible for treatment of waste contaminated with petroleum hydrocarbons. These technologies have successfully treated kerosene and oily sludges. Land farming is not implementable on site at Selfridge ANGB because the technology requires extensive areas of land in an area distant from people. Land treatment is effective if it is well managed. It can successfully eliminate the petroleum hydrocarbons from the contaminated soil over a period of years. On-site land treatment is economically feasible because its cost is only moderate. Off-site land treatment is not economical because commercial units are in distant locations.

Conclusion: Land farming does not pass screening at any of the sites because the distance to commercial facilities adversely impacts implementability.

5.2.5.6 Out-of-Ground Physical Treatment

Solidification

Solidification of contaminated soil is technically feasible because adsorption of any free water in the soil is easy to accomplish. After free water is removed the waste is solidified. Case studies exist of solidification of oil-bearing sludge. Solidification is easy to implement because ordinary earthmoving equipment or industrial mixers are the only special equipment needed. Solidification is not effective because simple solidification does not address leachate generation and movement. Solidified waste may release liquids when compressed. Even if the waste is moved someplace else, the leachate remains objectionable. Solidification is economically feasible because it has a moderate cost.

Conclusion: Solidification does not pass screening for any of the sites because it merely implies a binding of free water and not necessarily permanent containment of the contaminants.

5.2.5.7 Out-of-Ground Chemical Treatment

Surface Water Treatment

Treatment of surface water is technically feasible at any of the Selfridge ANGB sites where continued releases of contaminants are possible. Surface water treatment is easy to implement because portable units are available. Surface water treatment is economically feasible because of its modest cost. Ancillary water storage increases cost and effectiveness.

Conclusion: Surface water treatment passes screening at all sites.

Stabilization

Stabilization of inorganic waste is technically possible. It is possible that organic waste might be capable of stabilization through encapsulation, but the preferable reaction of stabilization through fixation does not occur with organic waste. Stabilization is easy to implement using earthmoving equipment or industrial mixers. Stabilization is effective because it chemically immobilizes the contaminants. Stabilization is economically feasible because it has a moderate cost.

Conclusion: Stabilization does not pass screening at any of the sites except the BCSP because there are no situations except the BCSP consisting solely of low-concentration metals contamination that would be amenable to stabilization.

Chemical Extraction

Chemical extraction may be technically feasible for soils at Selfridge ANGB which are contaminated with petroleum hydrocarbons, but there are no field-scale studies to confirm feasibility.

The technology is not readily implementable because there are no established vendors of the specialized equipment. Chemical extraction would be effective because it would eliminate petroleum hydrocarbons from the soil. Chemical extraction is not economically feasible because it has a relatively high cost.

Conclusion: Chemical extraction does not pass screening at any of the sites because implementability is adversely impacted due to the lack of established vendors.

Groundwater treatment

Groundwater treatment is technically feasible at any of the Selfridge ANGB sites. Many technologies are available for on- and off-site groundwater treatment. The technology is readily implementable because treatment systems are relatively easy to obtain, assemble, and operate. Groundwater treatment is effective because these systems permanently remove contaminants from the groundwater. The technology is economically feasible because of its modest cost.

Conclusion: Groundwater treatment passes screening at all sites.

5.2.5.8 Out-of-Ground Thermal Treatment

Low-Temperature Thermal Treatment

Low-temperature thermal treatment is technically feasible at any of the sites contaminated with petroleum hydrocarbons or

volatile organic compounds. Low-temperature thermal treatment is not technically feasible for the other sites because it specifically removes VOCs and hydrocarbons. Low-temperature thermal treatment is implementable because the machines can be brought to the site or operated at central locations. Low-temperature thermal treatment is effective because it destroys the waste. The technology is economically feasible due to its moderate cost.

Conclusion: Low-temperature thermal treatment passes screening at FTA-2, FTA-1, ERMP, and WRMP because their contaminants lend themselves to low-temperature thermal treatment.

Rotary Kiln Incineration

Rotary kiln incineration is technically feasible at all sites except the landfills; the potential physical heterogeneity of the landfill waste would cause significant materials handling problems. Incineration can reduce the volume of the waste, and it can destroy organic contaminants. The technology is readily implemented. Both on- and off-site incinerators are available. Incineration is effective because it destroys the waste. Incineration is economically feasible only at small, contaminated sites, such as FTA-2 and FTA-1, due to its high cost.

Conclusion: Rotary kiln incineration passes screening at FTA-2 and FTA-1 because they are significantly contaminated and have a volume of contaminated soil that can be treated in a reasonable time period.

5.2.6 Disposal Technologies

5.2.6.1 In Situ Disposal

In situ disposal is technically feasible at any of the Selfridge ANGB sites. In situ disposal is implementable because it is currently occurring. In situ disposal is not effective unless attempted in conjunction with a waste treatment or control program because alone it does nothing to reduce the contaminant source or migration. In situ disposal is economically feasible because of its relatively low cost.

Conclusion: In situ disposal passes screening at all sites with the expectation that it will be combined with a treatment or containment technology.

5.2.6.2 On-Site Disposal

On-site disposal of treated soil and water is technically feasible because waste excavation operations leave pits that must be backfilled. On-site disposal's effectiveness depends on the success of treatment prior to disposal. On-site disposal of untreated soil or water is not considered environmentally effective because it cannot reduce the mobility, toxicity, or

volume of the contaminated material. On-site disposal is effective because on-site disposal avoids transportation costs.

Conclusion: On-site disposal passes screening at all sites where some type of treatment also passes screening.

5.2.6.3 Off-Site Disposal

Off-site disposal is technically feasible for all sites at Selfridge ANGB. Numerous commercial solid and hazardous waste landfills are available to receive treated waste residuals. The technology is implementable for all sites except SWLF, TCLF, and NWLF. To apply off-site disposal to the Selfridge ANGB landfills would lead to enormous transportation difficulties. Noise, dust, odors, and engine emissions could practically offset the environmental benefits of the excavation program. Proper containment in an off-site disposal unit is effective, particularly if the waste also receives treatment prior to disposal. Off-site disposal is economically feasible at all sites other than the landfills where the large volumes would cause extraordinary costs.

Conclusion: Off-site disposal passes screening at all sites except the base landfills because of the impracticality of excavating and moving existing landfills.

5.3 ASSEMBLY OF OPERABLE UNITS

This subsection assembles the screened technologies into operable units. Operable units are discrete parts of an entire response action that decreases a release, threat of release, or pathway of exposure. The operable units assembled here were developed on the basis of measures that could be taken with respect to the three potentially contaminated media at the IRP sites -- soil, groundwater, and surface water -- on a site-by-site basis. The no action technology is an unnumbered operable unit for all media at all sites.

The operable units assembled for each site were combined into preliminary remedial alternatives using a tabular matrix format, with each alternative containing one operable unit for each potentially affected medium. The matrices are intended to illustrate the range of possible remedial alternatives and are not considered to be exhaustive. The preliminary alternatives shown in the matrices will be used to refine the objectives of subsequent field investigations and to identify critical data needed for a detailed evaluation of alternatives.

5.3.1 Southwest Landfill

Table 5-3 presents the operable units for SWLF.

Table 5-3

Southwest Landfill Remedial Alternatives Matrix,
IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL1	GW	GW1	GW2	GW3	GW4
	No action	In situ disposal Access Deed	No action	Monitoring Access Deed	Vertical barriers (requires use of SW2) Monitoring Access Deed	Infiltration control Monitoring Access Deed	Extraction Treatment On-site disposal (water) Off-site disposal (water and sludge) Monitoring
Remedial Alternative							
01	X	--	X	--	--	--	--
02	--	X	--	X	--	--	--
03	--	X	--	--	--	X	--
04	--	X	--	--	--	--	X
05	--	X	--	X	--	--	--
06	--	X	--	--	X	--	--
07	--	X	--	--	--	X	--
08	--	X	--	--	--	--	X
09	--	X	--	X	--	--	--
10	--	X	--	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Table 5-3
(continued)

Operable Unit	SW	SW1	SW2	SW3
	No action	Monitoring Access Deed	Capping Monitoring Access Deed	Interception (within sewer system) Treatment On-site disposal (water) Off-site disposal (water and sludge)
Remedial <u>Alternative</u>				
01	X	--	--	--
02	--	X	--	--
03	--	X	--	--
04	--	X	--	--
05	--	--	X	--
06	--	--	X	--
07	--	--	X	--
08	--	--	X	--
09	--	--	--	X
10	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Soil

Operable unit SL1:

Leave waste mass in situ, making provision for limitation of contaminant transport. Impose access and deed restrictions. Use of this operable unit is implied if any action is taken with respect to surface water or groundwater.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Operable unit GW2:

Install vertical barriers around the landfill perimeter to prevent the spread of contaminated groundwater and the influx of clean groundwater. Requires use of capping (operable unit SW2). Periodically monitor groundwater quality. Impose access and deed restrictions.

Operable unit GW3:

Reduce infiltration of groundwater into nearby stormwater sewers by lining, grouting, or replacing the sewers. Periodically monitor groundwater quality. Impose access and deed restriction. Incompatible with operable unit SW3.

Operable unit GW4:

Extract contaminated groundwater. Treat the groundwater on or off site. Dispose of treated water on or off site. Dispose of treatment sludges off site. Periodically monitor groundwater quality until clean.

Surface Water

Operable unit SW1:

Periodically monitor the surface water. Impose access and deed restrictions to limit human contact with contaminated surface water.

Operable unit SW2:

Install a landfill cap to reduce infiltration and to promote runoff drainage without ponding. Periodically monitor the water quality in adjacent ditches. Impose access and deed restrictions.

Operable unit SW3:

Provide structures for storing and controlling flow within the stormwater drainage system. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site. Incompatible with operable unit GW3.

5.3.2 Fire Training Area 2

Table 5-4 presents the operable units for FTA-2.

Soil

Operable unit SL1:

Dispose of soil in situ. Impose access and deed restrictions to limit human contact with contaminated soil.

Operable unit SL2:

Conduct in situ RF heating. Dispose of the treated soil simply by leaving it in situ. This operable unit requires use of SW2 to prevent reoccurrence of contamination.

Operable unit SL3:

Excavate the contaminated soil and pass it through a low-temperature thermal treatment unit, either on or off site. If on-site treatment is performed, backfill the excavated hole with treatment residuals. If off-site treatment is performed, dispose of the treatment residuals off site, and backfill the hole with recompacted clay. This operable unit requires use of SW2 to prevent reoccurrence of contamination.

Operable unit SL4:

Excavate the contaminated soil and pass it through a rotary kiln incinerator, either on site or off site. Dispose of the ash either on or off site. Complete backfilling of the excavation with recompacted clay. This operable unit requires use of SW2 to prevent reoccurrence of contamination.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Operable unit GW2:

Reduce infiltration of groundwater into nearby stormwater sewers by lining, grouting, or replacing the sewers. Periodically

Table 5-4

Fire Training Area 2 Remedial Alternatives Matrix, IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL1	SL2	SL3	SL4
	No action	In situ disposal Access Deed	In situ RF heating In situ disposal (soil) (requires use of SW2)	Excavation Low-temp thermal (on/off) On-site disposal (soil) Off-site disposal (soil) (requires use of SW2)	Excavation Incineration (on/off) On-site disposal (ash) Off-site disposal (ash) (requires use of SW2)
Remedial Alternative					
01	X	--	--	--	--
02	--	X	--	--	--
03	--	X	--	--	--
04	--	X	--	--	--
05	--	--	X	--	--
06	--	--	X	--	--
07	--	--	X	--	--
08	--	--	--	X	--
09	--	--	--	X	--
10	--	--	--	X	--
11	--	--	--	--	X
12	--	--	--	--	X
13	--	--	--	--	X
14	--	X	--	--	--
15	--	X	--	--	--

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Table 5-4
(continued)

Operable Unit	GW	GW1	GW2	GW3	SW	SW1	SW2	SW3
	No action	Monitoring Access Deed	Infiltration control Monitoring Access Deed	Extraction Treatment On-site disposal (water) Off-site disposal (water and sludge) Monitoring	No action	Monitoring Access Deed	Interception (concrete burn pit) Treatment On-site disposal (water) Off-site disposal (water and sludge	Interception (within sewer system) Treatment On-site disposal (water) Off-site disposal (water and sludge) (not needed if soil treated)
Remedial <u>Alternative</u>								
01	X							
02	--	X	--	--	X	--	--	--
03	--	--	X	--	--	X	--	--
04	--	--	--	X	--	X	--	--
05	--	X	--	--	--	X	X	--
06	--	--	X	--	--	--	X	--
07	--	--	--	X	--	--	X	--
08	--	X	--	--	--	--	X	--
09	--	--	X	--	--	--	X	--
10	--	--	--	X	--	--	X	--
11	--	X	--	--	--	--	X	--
12	--	--	X	--	--	--	X	--
13	--	--	--	X	--	--	X	--
14	--	X	--	--	--	--	--	X
15	--	--	--	X	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

monitor groundwater quality. Impose access and deed restrictions.

Surface Water

Operable unit GW3:

Extract contaminated groundwater. Treat the groundwater either on or off site. Dispose of treated water on or off site. Dispose of treatment sludges off site. Periodically monitor the groundwater quality until clean.

Operable unit SW1:

Periodically monitor the surface water. Impose access and deed restrictions to limit human contact with contaminated surface water.

Operable unit SW2:

Install a lined concrete burn pit with ancillary facilities to prevent future fire training exercises from contaminating the surface water. The pad should feature curbs, water collection, and water storage. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site.

Operable unit SW3:

Provide structures for storing and controlling flow within the stormwater drainage system. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site. This operable unit is not needed if soil treatment is performed.

5.3.3 Fire Training Area 1

Table 5-5 presents the operable units for FTA-1.

Soil

Operable unit SL1:

Dispose of soil in situ. Impose access and deed restrictions to limit human contact with contaminated soil.

Operable unit SL2:

Conduct in situ chemical reaction using a surfactant flushing approach. Dispose of treated process water on site. Dispose of surfactant-oil compounds off site. Dispose of the treated soil simply by leaving it in situ.

Table 5-5

Fire Training Area 1 Remedial Alternatives Matrix, IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL1	SL2	SL3	SL4	SL5
	No action	In situ disposal Access Deed	In situ chemical In situ disposal (soil) On-site disposal (water) Off-site disposal (sludge)	In situ RF heating In situ disposal (soil)	Excavation Low-temp thermal (on/off) On-site disposal (soil) Off-site disposal (soil)	Excavation Incineration (on/off) On-site disposal (ash) Off-site disposal (ash)
Remedial Alternative						
01	X	--	--	--	--	--
02	--	X	--	--	--	--
03	--	X	--	--	--	--
04	--	--	X	--	--	--
05	--	--	X	--	--	--
06	--	--	--	X	--	--
07	--	--	--	X	--	--
08	--	--	--	--	X	--
09	--	--	--	--	X	--
10	--	--	--	--	--	X
11	--	--	--	--	--	X
12	--	X	--	--	--	--
13	--	X	--	--	--	--

SW - Surface water
SL - Soil
GW - Groundwater
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Table 5-5
(continued)

Operable Unit	GW	GW1	GW2	SW	SW1
	No action	Monitoring Access Deed	Extraction Treatment On-site disposal (water) Off-site disposal (water and sludge) Monitoring	No action	Capping Access Deed (not needed if soil treated)
Remedial Alternative					
01	X	--	--	X	--
02	--	X	--	X	--
03	--	--	X	X	--
04	--	X	--	X	--
05	--	--	X	X	--
06	--	X	--	X	--
07	--	--	X	X	--
08	--	X	--	X	--
09	--	--	X	X	--
10	--	X	--	X	--
11	--	--	X	X	--
12	--	X	--	--	X
13	--	--	X	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Operable unit SL3:

Conduct in situ RF heating. Dispose of the treated soil simply by leaving it in situ.

Operable unit SL4:

Excavate the soil and pass it through a low-temperature thermal treatment unit, either on or off site. If on-site treatment is performed, backfill the excavated hole with treatment residuals. If off-site treatment is performed, dispose of the treatment residuals, and backfill the hole with recompacted clay.

Operable unit SL5:

Excavate the contaminated soil and pass it through a rotary kiln incinerator, either on or off site. Dispose of the ash either on or off site. Complete backfilling of the excavation with recompacted clay.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Operable unit GW2:

Extract contaminated groundwater. Treat the groundwater either on or off site. Dispose of treated water on or off site. Dispose of treatment sludges off site. Periodically monitor the groundwater quality until clean.

Surface Water

Operable unit SW1:

Divert precipitation from the site with a cap. This will also reduce contamination of groundwater by reducing percolation through contaminated soil. Impose access and deed restrictions to prevent damage to the cap. This operable unit would not be needed if treatment action is taken with respect to soil contamination.

5.3.4 West Ramp

Table 5-6 presents the operable units for WRMP.

Table 5-6

West Ramp Remedial Alternatives Matrix, IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL1	SL2	GW	GW1	GW2	GW3
	No action	In situ disposal Access Deed	Excavation Low-temp thermal (on/off) On-site disposal (soil) Off-site disposal (soil)	No action	Monitoring Access Deed	Infiltration control Monitoring Access Deed	Extraction Treatment On-site disposal (water) Off-site disposal (water and sludge) Monitoring
Remedial Alternative							
01	X	--	--	X	--	--	--
02	--	X	--	--	X	--	--
03	--	X	--	--	--	X	--
04	--	X	--	--	--	--	X
05	--	--	X	--	X	--	--
06	--	--	X	--	--	X	--
07	--	--	X	--	--	--	X
08	--	X	--	--	X	--	--
09	--	X	--	--	--	X	--
10	--	X	--	--	--	--	X
11	--	--	X	--	X	--	--
12	--	--	X	--	--	X	--
13	--	--	X	--	--	--	X
14	--	X	--	--	X	--	--
15	--	X	--	--	--	--	X
16	--	--	X	--	X	--	--
17	--	--	X	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Table 5-6
(continued)

Operable Unit	SW	SW1	SW2	SW3
	No action	Monitoring Access Deed	Interception (surface storage) Treatment On-site disposal (water) Off-site disposal (water and sludge)	Interception (within sewer system) Treatment On-site disposal (water) Off-site disposal (water and sludge)
Remedial Alternative				
01	X	--	--	--
02	--	X	--	--
03	--	X	--	--
04	--	X	--	--
05	--	X	--	--
06	--	X	--	--
07	--	X	--	--
08	--	--	X	--
09	--	--	X	--
10	--	--	X	--
11	--	--	X	--
12	--	--	X	--
13	--	--	X	--
14	--	--	--	X
15	--	--	--	X
16	--	--	--	X
17	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Soil

Operable unit SL1:

Dispose of soil in situ. Impose access and deed restrictions to limit human contact with contaminated soil.

Operable unit SL2:

Excavate the contaminated soil and pass it through a low-temperature thermal treatment unit, either on or off site. If on-site treatment is performed, backfill the excavated hole with treatment residuals. If off-site treatment is performed, dispose of the treatment residuals off site, and backfill the hole with recompacted clay.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Operable unit GW2:

Reduce infiltration of groundwater into nearby stormwater sewers by lining, grouting, or replacing the sewers. Periodically monitor the groundwater quality. Impose access and deed restrictions.

Operable unit GW3:

Extract contaminated groundwater. Treat the groundwater either on or off site. Dispose of treated water on or off site. Dispose of treatment sludges off site. Periodically monitor the groundwater quality until clean.

Surface Water

Operable unit SW1:

Periodically monitor the surface water. Impose access and deed restrictions to limit human contact with contaminated surface water.

Operable unit SW2:

Build structures to intercept and hold contaminated surface runoff from the ramp. Make provisions for on- or off-site treatment. Dispose of treated water on or off site. Dispose of treatment sludges off site.

Operable unit SW3:

Provide structures for storing and controlling flow within the stormwater drainage system. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site.

5.3.5 Tucker Creek Landfill

Table 5-7 presents the operable units for TCLF.

Soil

Operable unit SL1:

Leave waste mass in situ, making provisions for limiting contaminant transport. Impose access and deed restrictions. Use of this operable unit is implied if any action is taken with respect to surface water or groundwater.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Operable unit GW2:

Install vertical barriers around the landfill perimeter to prevent the spread of contaminated groundwater and the influx of clean groundwater. Requires use of capping (operable unit SW2). Periodically monitor the groundwater quality. Impose access and deed restrictions.

Operable unit GW3:

Reduce infiltration of groundwater into nearby stormwater sewers by lining, grouting, or replacing the sewers. Periodically monitor the groundwater quality. Impose access and deed restrictions.

Operable unit GW4:

Extract contaminated groundwater. Treat the groundwater either on or off site. Dispose of treated water on or off site. Dispose of treatment sludges off site. Periodically monitor the groundwater quality until clean.

Surface Water

Operable unit SW1:

Periodically monitor the surface water. Impose access and deed restrictions to limit human contact with contaminated surface water.

Table 5-7

Tucker Creek Landfill Remedial Alternatives Matrix, IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL1	GW	GW1	GW2	GW3	GW4
	No action	In situ disposal Access Deed	No action	Monitoring Access Deed	Vertical barriers (requires use of SW2) Monitoring Access Deed	Infiltration control Monitoring Access Deed	Extraction Treatment On-site dispoal (water) Off-site disposal (water and sludge) Monitoring
Remedial Alternative							
01	X	--	X	--	--	--	--
02	--	X	--	X	--	--	--
03	--	X	--	--	--	X	--
04	--	X	--	--	--	--	X
05	--	X	--	X	--	--	--
06	--	X	--	--	X	--	--
07	--	X	--	--	--	X	--
08	--	X	--	--	--	--	X
09	--	X	--	X	--	--	--
10	--	X	--	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

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Table 5-7
(continued)

Operable Unit	SW	SW1	SW2	SW3
	No action	Monitoring Access Deed	Capping Access Deed	Interception (within sewer system) Treatment On-site disposal (water) Off-site disposal (water and sludge)
Remedial <u>Alternative</u>				
01	X	--	--	--
02	--	X	--	--
03	--	X	--	--
04	--	X	--	--
05	--	--	X	--
06	--	--	X	--
07	--	--	X	--
08	--	--	X	--
09	--	--	--	X
10	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Operable unit SW2:

Install a landfill cap to divert precipitation from the site and to reduce percolation through the waste to groundwater. Impose access and deed restrictions to prevent damage of the cap.

Operable unit SW3:

Provide structures for storing and controlling flow within the stormwater drainage system. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site.

5.3.6 Northwest Landfill

Table 5-8 presents the operable units for NWLF.

Soil

Operable unit SL1:

Leave waste mass in situ, making provision for limitation of contaminant transport. Impose access and deed restrictions. Use of this operable unit is implied, if any action is taken with respect to surface water or groundwater.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Operable unit GW2:

Install vertical barriers around the landfill perimeter to prevent the spread of contaminated groundwater and the influx of clean groundwater. Requires use of capping (operable unit SW2). Periodically monitor the groundwater quality. Impose access and deed restrictions.

Operable unit GW3:

Reduce infiltration of groundwater into nearby stormwater sewers by lining, grouting, or replacing the sewers. Periodically monitor the groundwater quality. Impose access and deed restrictions.

Operable unit GW4:

Extract contaminated groundwater. Treat the groundwater either on or off site. Dispose of treated water on or off site. Dis-

Table 5-8

Northwest Landfill Remedial Alternatives Matrix, IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL2	GW	GW1	GW2	GW3	GW4
	No action	In situ disposal Access Deed	No action	Monitoring Access Deed	Vertical barriers (requires use of SW2) Monitoring Access Deed	Infiltration control Monitoring Access Deed	Extraction Treatment On-site dispoal (water) Off-site disposal (water and sludge) Monitoring
Remedial <u>Alternative</u>							
01	X	--	X	--	--	--	--
02	--	X	--	X	--	--	--
03	--	X	--	--	--	X	--
04	--	X	--	--	--	--	X
05	--	X	--	X	--	--	--
06	--	X	--	--	X	--	--
07	--	X	--	--	--	X	--
08	--	X	--	--	--	--	X
09	--	X	--	X	--	--	--
10	--	X	--	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Table 5-8
(continued)

Operable Unit	SW	SW1	SW2	SW3
	No action	Monitoring Access Deed	Capping Access Deed	Interception (within sewer system) Treatment On-site disposal (water) Off-site disposal (water and sludge)
Remedial <u>Alternative</u>				
01	X	--	--	--
02	--	X	--	--
03	--	X	--	--
04	--	X	--	--
05	--	--	X	--
06	--	--	X	--
07	--	--	X	--
08	--	--	X	--
09	--	--	--	X
10	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

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pose of treatment sludges off site. Periodically monitor the groundwater quality until clean.

Surface Water

Operable unit SW1:

Periodically monitor the surface water. Impose access and deed restrictions to limit human contact with contaminated surface water.

Operable unit SW2:

Install a landfill cap to divert precipitation from the site and to reduce percolation through the waste to groundwater. Impose access and deed restrictions to prevent damage to the cap.

Operable unit SW3:

Provide structures for storing and controlling flow within the stormwater drainage system. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site.

5.3.7 East Ramp

Table 5-9 presents the operable units for ERMP.

Soil

Operable unit SL1:

Dispose of soil in situ. Impose access and deed restrictions to limit human contact with contaminated soil.

Operable unit SL2:

Excavate the contaminated soil and pass it through a low-temperature thermal treatment unit, either on or off site. If on-site treatment is performed, backfill the excavated hole with treatment residuals. If off-site treatment is performed, dispose of the treatment residuals off site, and backfill the hole with recompacted clay.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Table 5-9

East Ramp Remedial Alternatives Matrix, IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL1	SL2	GW	GW1	GW2	GW3
	No action	In situ disposal Access Deed	Excavation Low-temp thermal (on/off) On-site disposal (soil) Off-site disposal (soil)	No action	Monitoring Access Deed	Infiltration control Monitoring Access Deed	Extraction Treatment On-site disposal (water) Off-site disposal (water and sludge) Monitoring
Remedial <u>Alternative</u>							
01	X	--	--	X	--	--	--
02	--	X	--	--	X	--	--
03	--	X	--	--	--	X	--
04	--	X	--	--	--	--	X
05	--	--	X	--	X	--	--
06	--	--	X	--	--	X	--
07	--	--	X	--	--	--	X
08	--	X	--	--	X	--	--
09	--	X	--	--	--	X	--
10	--	X	--	--	--	--	X
11	--	--	X	--	X	--	--
12	--	--	X	--	--	X	--
13	--	--	X	--	--	--	X
14	--	X	--	--	X	--	--
15	--	X	--	--	--	--	X
16	--	--	X	--	X	--	--
17	--	--	X	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Table 5-9
(continued)

Operable Unit	SW	SW1	SW2	SW3
	No action	Monitoring Access Deed	Interception (surface storage) Treatment On-site disposal (water) Off-site disposal (water and sludge)	Interception (within sewer system) Treatment On-site disposal (water) Off-site disposal (water and sludge)
Remedial Alternative				
01	X	--	--	--
02	--	X	--	--
03	--	X	--	--
04	--	X	--	--
05	--	X	--	--
06	--	X	--	--
07	--	X	--	--
08	--	--	X	--
09	--	--	X	--
10	--	--	X	--
11	--	--	X	--
12	--	--	X	--
13	--	--	X	--
14	--	--	--	X
15	--	--	--	X
16	--	--	--	X
17	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Operable unit GW2:

Reduce infiltration of groundwater into nearby stormwater sewers by lining, grouting, or replacing the sewers. Periodically monitor the groundwater quality. Impose access and deed restrictions.

Operable unit GW3:

Extract contaminated groundwater. Treat the groundwater either on or off site. Dispose of treated water on or off site. Dispose of treatment sludges off site. Periodically monitor the groundwater quality until clean.

Surface Water

Operable unit SW1:

Periodically monitor the surface water. Impose access and deed restrictions to limit human contact with contaminated surface water.

Operable unit SW2:

Build structures to intercept and hold contaminated runoff from the ramp. Make provisions for on- or off-site treatment. Dispose of treated water on or off site. Dispose of treatment sludges off site.

Operable unit SW3:

Provide structures for storing and controlling flow within the stormwater drainage system. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site.

5.3.8 Base Coal Storage Pile

Table 5-10 presents the operable units for the BCSP.

Soil

Operable unit SL1:

Dispose of soil in situ. Impose access and deed restrictions to limit human contact with contaminated soil.

Operable unit SL2:

Excavate and perform chemical stabilization on the metallic contaminants in the soil. Dispose of the soil off site or in its original location. Stabilization requires use of operable unit SW2 to prevent reoccurrence of contamination.

Table 5-10

Base Coal Storage Pile Remedial Alternatives Matrix, IRP Stage 2, Selfridge ANGB, MI

Operable Unit	SL	SL1	SL2	GW	GW1	GW2	GW3
	No action	In situ disposal Access Deed	Excavation Stabilization On-site disposal (soil) Off-site disposal (soil) (requires use of SW2)	No action	Monitoring Access Deed	Infiltration control Monitoring Access Deed	Extraction Treatment On-site disposal (water) Off-site disposal (water and sludge) Monitoring
Remedial Alternative							
01	X	--	--	X	--	--	--
02	--	X	--	--	X	--	--
03	--	X	--	--	--	X	--
04	--	X	--	--	--	--	X
05	--	X	--	--	X	--	--
06	--	X	--	--	--	X	--
07	--	X	--	--	--	--	X
08	--	--	X	--	X	--	--
09	--	--	X	--	--	X	--
10	--	--	X	--	--	--	X
11	--	X	--	--	X	--	--
12	--	X	--	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Table 5-10
(continued)

Operable Unit	SW	SW1	SW2	SW3
	No action	Monitoring Access Deed	Interception (concrete storage) Treatment On-site disposal (water) Off-site disposal (water and sludge)	Interception (within sewer system) Treatment On-site disposal (water) Off-site disposal (water and sludge)
Remedial <u>Alternative</u>				
01	X	--	--	--
02	--	X	--	--
03	--	X	--	--
04	--	X	--	--
05	--	--	X	--
06	--	--	X	--
07	--	--	X	--
08	--	--	X	--
09	--	--	X	--
10	--	--	X	--
11	--	--	--	X
12	--	--	--	X

SL - Soil
GW - Groundwater
SW - Surface water
X - Acceptable operable unit for remedial alternative.
-- - Not appropriate.

Groundwater

Operable unit GW1:

Periodically monitor the groundwater. Impose access and deed restrictions to limit human contact with contaminated groundwater.

Operable unit GW2:

Reduce infiltration of groundwater into nearby stormwater sewers by lining, grouting, or replacing the sewers. Periodically monitor the groundwater quality. Impose access and deed restrictions.

Operable unit GW3:

Extract contaminated groundwater. Treat the groundwater either on or off site. Dispose of treated water on or off site. Dispose of treatment sludges off site. Periodically monitor the groundwater quality until clean.

Surface Water

Operable unit SW1:

Periodically monitor the surface water. Impose access and deed restrictions to limit human contact with contaminated surface water.

Operable unit SW2:

Install a lined concrete pad with curbs and water storage capability to intercept runoff and infiltration. Provide for on- or off-site water treatment. Dispose of treated water on or off site. Dispose of treatment sludges off site.

Operable unit SW3:

Provide structures for storing and controlling flow within the stormwater drainage system. Provide on- or off-site treatment of surface water. Dispose of treated water on or off site. Dispose of treatment sludges off site.

SECTION 6

SUMMARY AND CONCLUSIONS

6.1 NATURE AND EXTENT OF CONTAMINATED AT SITE NO. 1 (SWLF)

Soil borings were not installed during the Phase II Stage 2 investigation at this site. A total of four soil samples were collected from monitoring well borings 01-257, 01-259, 01-261, and 01-263. The soil sampling locations were chosen because the borings for monitoring wells 01-259 and 01-263 were believed to be upgradient, and the borings for monitoring wells 01-257 and 01-261 were believed to be downgradient of the landfill. During drilling, however, monitoring well 01-259 was discovered to be within the landfill rather than outside the originally defined boundary of the site. A subsequent examination of historical aerial photographs revealed two additional areas used for waste disposal in the vicinity of the SWLF site. Based upon the dates the photographs were taken, both areas pre-date the existing SWLF site. Neither of these areas were evaluated for extent of contamination during this study.

Four shallow monitoring wells (01-122, 01-123, 01-124, and 01-125) were installed and sampled during the Phase II Stage 1 investigation. During the Phase II Stage 2 investigation, eight additional monitoring wells were installed around and within the perimeter of the SWLF: four shallow wells (01-156, 01-158, 01-160, 01-162), and four deep wells (01-257, 01-259, 01-261, and 01-263). During the Phase II Stage 2 investigation, all twelve monitoring wells were sampled. Visible signs of potential subsurface contamination encountered during Phase II Stage 2 drilling at SWLF were limited to monitoring well nest 01-158/259. Gray clay mixed with the waste material in this interval displayed a greasy appearance. A strong, sewage-like odor was also detected during the advancement of these boreholes through the upper 15 feet of material. Based on the potentiometric surface maps, groundwater flow is generally toward the east and south in the shallow aquifer and toward the southeast in the deeper aquifer.

Two intermittent drainage ditches convey surface water runoff from the area around the SWLF. Drainage of surface water directly off the site is not controlled by engineered features. As part of the investigation, five surface water sampling stations were established at the SWLF. One station (01-504) was placed in the pump house on the southwestern edge of the SWLF. Two other stations (01-501 and 01-503) were placed in ponding areas on the SWLF. Station 01-505 was placed by Taxiway C at a storm sewer manhole. Station 01-502 was located within the drainage ditch that meanders around the SWLF.

The SWLF is currently an active site for the disposal of demolition debris, miscellaneous equipment, and appliances. Access to the SWLF is not restricted by any physical means.

6.1.1 Soil Contamination

No soil samples were collected at the SWLF during the Phase II Stage 1 investigation.

During the Phase II Stage 2 investigation at Site No. 1, one duplicate and four investigative soil samples were collected from monitoring well borings 01-257, 01-259, 01-261, and 01-263. All samples were submitted for laboratory analysis of petroleum hydrocarbons, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), soil moisture content, and metals screen including arsenic, mercury, and selenium.

6.1.1.1 Soil Quality

Table 6-1 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-1
Maximum Concentrations Detected in Soil at Site No. 1
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/kg)	Act 307 Type B Cleanup Criteria for Soil[a] and/or Estimated Background Levels[b] (mg/kg)
Bis(2-ethylhexyl)phthalate	0.12	0.04[a]
Phenanthrene	0.18	ID
Benzo(g,h,i)perylene	0.11	ID
Petroleum hydrocarbons	180	ND
Mercury	0.959	0.040
Nickel	382	41.8[b]
Lead	22.9	--
Zinc	78.3	70[b]

ID = Insufficient data.
ND = Not determined.
mg/kg = milligrams per kilogram.

SVOCs were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels in only one soil sample collected from Site No. 1. The SVOCs bis(2-ethylhexyl)phthalate, phenanthrene and benzo(g,h,i)perylene were detected at the concentrations shown in Table 6-1 in soil sample 01-357-B001 collected from a depth of 4.0 to 8.0 feet below land surface (fbls).

Petroleum hydrocarbons were detected at a concentration of 180 mg/kg in soil sample 01-359-B001 collected from a depth of 10.0 to 15.0 fbls and at 77 mg/kg in soil sample 01-363-B001 collected from a depth of 15.0 to 20.0 fbls.

All metal concentrations were within the naturally occurring observed ranges for the eastern United States (see Table 4-19). However, four metals were detected at concentrations exceeding background levels for Selfridge ANGB (see Table 1-1). Lead was not detected in soil sample 01-357-B001 collected from a depth of 4.0 to 8.0 fbls, but was detected at a concentration of 22.9 mg/kg in the duplicate sample collected from the same depth. Mercury was detected at a concentration of 0.959 mg/kg and zinc at 78.3 mg/kg in soil sample 01-359-B001 collected from a depth of 10.0 to 15.0 fbls. Nickel was detected at a concentration of 382 mg/kg in soil sample 01-363-B001 collected from a depth of 15.0 to 20.0 fbls.

6.1.1.2 Extent of Soil Contamination

No soil contamination was evident in the soil sample collected from monitoring well boring 01-261, located northeast of the SWLF site. SVOC contamination in soil appears limited to monitoring well boring 01-257, located southeast of the SWLF. The SVOCs detected are typical of coal tar or wood preservatives and suggest the presence of buried railroad ties or asphalt.

The soil sample collected from monitoring well boring 01-259 had the following contaminants detected: petroleum hydrocarbons (180 mg/kg), mercury (0.959 mg/kg), and zinc (78.3 mg/kg). This boring was installed in landfill material. Petroleum hydrocarbons were detected at a concentration of 77 mg/kg and nickel at 382 mg/kg in the soil sample collected from monitoring well boring 01-263, located approximately 500 feet south of monitoring well boring 01-259. Lead was detected in the duplicate soil sample collected from monitoring well boring 01-257, located to the southeast of the SWLF.

6.1.2 Groundwater Contamination

During the Phase II Stage 2 investigation at Site No. 1, twelve monitoring wells were sampled. One duplicate and twelve groundwater samples were collected. All samples were submitted for laboratory analysis of petroleum hydrocarbons, purgeable halocarbons, purgeable aromatics, extractable priority pollutants, alkalinity, common anions, ammonia, chemical oxygen demand (COD), total organic carbon (TOC), total dissolved solids (TDS), and metals screening including arsenic, lead, mercury, and selenium.

6.1.2.1 Groundwater Quality

Table 6-2 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 6-2), and/or Act 307 Type B Cleanup Criteria levels.

During the Phase II Stage 2 investigation, nine VOCs were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels in groundwater sampled at the SWLF (see Table 1-2). Most of the VOCs were detected in groundwater sampled from shallow monitoring wells 01-124 and 01-158, located on the western side of the site. The highest concentrations of VOCs were detected in samples collected from monitoring well 01-158. Trans-1,2-dichloroethene was detected at a concentration of 650 ug/L, methylene chloride at 310 ug/L, vinyl chloride at 68 ug/L, tetrachloroethene at 3.9 ug/L, 1,1,2,2-tetrachloroethane at 7.3 ug/L, trichloroethene at 170 ug/L, benzene at 60 ug/L, and 1,4-dichlorobenzene at 9 ug/L in groundwater sample 01-158-M001. 1,2-dichloroethane was detected at a concentration of 3.1 ug/L, vinyl chloride at 2.3 ug/L, trichloroethene at 6.7 ug/L, and benzene at 29 ug/L in groundwater sample 01-124-M001. Methylene chloride was the only VOC detected in groundwater sampled from deep monitoring wells. Methylene chloride was detected at concentrations of 6 ug/L and 13 ug/L in groundwater samples 01-257-M001 and 01-259-M001, respectively.

The SVOC bis(2-ethylhexyl)phthalate was detected in five of the twelve groundwater samples in concentrations ranging from 2 to 26 ug/L and may be indicative of laboratory contamination.

Petroleum hydrocarbons were detected at concentrations of 1 mg/L and 5 mg/L in groundwater sampled from shallow monitoring wells 01-158 and 01-160, respectively. Petroleum hydrocarbons were detected at concentrations of 2 mg/L and 6 mg/L in groundwater sampled from deep monitoring wells 01-263 and 01-257, respectively.

Metals were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels (see Table 6-2). All metals detected, with the exception of cadmium, were found in groundwater sampled from shallow monitoring wells. Arsenic was detected at a concentration of 0.01 mg/L in groundwater samples collected from monitoring wells 01-124 and 01-156. Boron was detected at concentrations ranging from 0.629 to 1.35 mg/L in four of the eight shallow monitoring wells sampled. Cadmium was detected at concentrations of 0.022 mg/L and 0.047 mg/L in groundwater sampled from monitoring wells 01-124 and 01-158, respectively. Iron was detected in concentrations ranging from 0.688 to 700 mg/L with the highest concentration detected in sample 01-158-M001. Zinc was detected at a concentration of 1.74 mg/L in groundwater sample 01-158-M001. Cadmium was the only metal to be detected in groundwater samples collected from deep monitoring wells at a concentration which exceeded Act 307 Type B Cleanup Criteria levels. Cadmium was detected at a concentration of 132 mg/L in the groundwater sample collected from deep monitoring well 01-263.

Table 6-2
Maximum Concentrations Detected in Groundwater at Site No. 1
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Groundwater[a] and/or Estimated Background Levels[b]
1,2-dichloroethane	3.1 ug/L	0.4 ug/L[a]
Trans-1,2-dichloroethene	650 ug/L	100 ug/L[a]
Methylene chloride	310 ug/L	5 ug/L[a]
Vinyl chloride	68 ug/L	0.02 ug/L[a]
Tetrachloroethene	3.9 ug/L	0.07 ug/L[a]
1,1,2,2-tetrachloroethane	7.3 ug/L	0.2 ug/L[a]
Trichloroethene	170 ug/L	3 ug/L[a]
Benzene	60 ug/L	1 ug/L[a]
1,4-dichlorobenzene	9 ug/L	1 ug/L[a]
Bis(2-ethylhexyl)phthalate	26 ug/L	1 ug/L[a]
Petroleum hydrocarbons	6 mg/L	ND
Arsenic	0.01 mg/L	0.00002 mg/L[a]
Boron	1.35 mg/L	0.6 mg/L[a]
Cadmium	132 mg/L	0.004 mg/L[a]
Iron	700 mg/L	0.3 mg/L[a]
Zinc	1.74 mg/L	1 mg/L[a]
Alkalinity	2,500 mg/L	670 mg/L[b]
COD	7,000 mg/L	100 mg/L[b]
TOC	2,000 mg/L	52 mg/L[b]
TDS	5,900 mg/L	1,400 mg/L[b]
Chloride	1,820 mg/L	250 mg/L[a]
Sulfate	475 mg/L	250 mg/L[a]

ND = Not determined.
COD = Chemical Oxygen Demand.
TOC = Total Organic Carbon.
TDS = Total Dissolved Solids.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter.

Several parameters were measured at concentrations exceeding background levels for Selfridge ANGB (see Table 6-2). Alkalinity concentrations ranged from 900 to 2,500 mg/L in four of the twelve samples analyzed. COD concentrations ranged from 380 to 7,000 mg/L in four samples. TOC was detected at concentrations of 1,100 mg/L and 2,000 mg/L in groundwater samples 01-124-M001 and 01-158-M001, respectively. TDS concentrations ranged from 1,800 to 5,900 mg/L in six samples and in the duplicate sample.

Chloride and sulfate were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels. Chloride was detected at concentrations ranging from 297 to 1,820 mg/L in six of the twelve groundwater samples. Sulfate was detected at a concentration of 475 mg/L in groundwater sample 01-122-M001.

6.1.2.2 Extent of Groundwater Contamination

VOC contamination was detected in groundwater sampled from shallow monitoring well 01-158, which was installed in landfill material, with the largest number of VOCs and the highest concentrations detected. VOC contamination was also detected in smaller numbers and at lower concentrations in groundwater sampled from shallow monitoring well 01-124. This well is located approximately 250 feet east and downgradient to monitoring well 01-258.

Petroleum hydrocarbons were detected in groundwater sampled from shallow monitoring well 01-160 and from deep monitoring well 01-257, both located east of the SWLF and downgradient to the site. Petroleum hydrocarbons were detected at a concentration of 5 mg/L and 6 mg/L in groundwater sampled from monitoring wells 01-160 and 01-257, respectively.

Arsenic was detected at a concentration of 0.01 mg/L in groundwater samples collected from monitoring wells 01-124 and 01-156. Cadmium was detected at concentrations of 0.022 mg/L in sample 01-124-M001, 0.047 mg/L in 01-158-M001, and 132 mg/L in sample 01-263-M001.

6.1.3 Surface Water Contamination

During the Phase II Stage 2 investigation at Site No. 1, one duplicate and five dry-event surface water samples, and one duplicate and five wet-event surface water samples were collected. All samples were submitted for laboratory analysis of petroleum hydrocarbons, purgeable halocarbons, purgeable aromatics, extractable priority pollutants, alkalinity, common anions, ammonia, COD, TOC, TDS, and metals screen including arsenic, lead, mercury, and selenium.

6.1.3.1 Surface Water Quality

Table 6-3 summarizes the contaminants and maximum concentrations detected in surface water samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-23), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-3
Maximum Concentrations Detected in Surface Water at Site No. 1
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for GSI[a] and/or Estimated Background Levels[b] (mg/L)
Trichlorofluoromethane	150 ug/L	N/A
Butyl benzyl phthalate	6 ug/L	N/A
Diethyl phthalate	6 ug/L	N/A
Di-n-butyl phthalate	2 ug/L	N/A
4-nitrophenol	12 ug/L	N/A
Petroleum hydrocarbons	2.4 mg/L	ND
Boron	0.942 mg/L	N/A
Barium (dry-event)	0.518 mg/L	0.354[b]
Cadmium	0.066 mg/L	0.0006[a]
Chromium	0.022 mg/L	0.0017[a]
Copper	0.032 mg/L	0.018[a]
COD (dry-event)	390 mg/L	57[b]
TOC (wet-event)	100 mg/L	34[b]
Sulfate	325 mg/L	100[b]

GSI = Groundwater/Surface Water Interface.
N/A = Not Available.
ND = Not determined.
COD = Chemical Oxygen Demand.
TOC = Total Organic Carbon.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter.

The sample collected at surface water station 01-501 exhibited the greatest concentration of contamination. The VOC trichlorofluoromethane was detected at concentrations of 150 ug/L and 70 ug/L in the dry-event and wet-event water samples, respectively. The SVOCs diethyl phthalate, di-n-butyl phthalate, and 4-nitrophenol were detected at concentrations of 6, 1, and 12 ug/L, respectively in the wet-event surface water sample. Several metals and parameters were detected at concentrations exceeding either Act 307 Type B Cleanup Criteria levels or background levels for Selfridge ANGB (see Table 6-3). Barium, chromium, and copper were detected at concentrations of 0.518, 0.022, and 0.032 mg/L, respectively, in the dry-event surface water sample. Cadmium was detected at concentrations of 0.066 mg/L and 0.005 mg/L in the dry-event and wet-event water samples, respectively. COD was measured at a concentration of 390 mg/L in the dry-event sample and TOC was measured at a concentration of 100 mg/L in the wet-event surface water sample. Sulfate was detected at a concentration of 199 mg/L in the dry-event surface water sample.

The SVOC butyl benzyl phthalate was detected at a concentration of 6 ug/L in surface water sample 01-504-W001. Di-n-butyl phthalate was also detected at concentrations of 1 ug/L and 2 ug/L in wet-event surface water samples 01-502-W002 and 01-503-W102, respectively.

Petroleum hydrocarbons were detected at concentrations ranging from 1.1 to 2.4 mg/L in dry-event surface water samples 01-501-W001, 01-502-W001, and 01-504-W001.

Boron was detected at concentrations ranging from 0.116 to 0.942 mg/L in all dry and wet event surface water samples with the exception of samples collected from stations 01-504 and 01-505. Several metals were detected at concentrations exceeding either Act 307 Type B Cleanup Criteria levels or background levels for Selfridge ANGB (see Table 6-3). Chromium was detected at a concentration of 0.017 mg/L in both the dry-event and wet-event surface water samples collected from station 01-502. Copper was detected at a concentration of 0.03 mg/L in dry-event water sample 01-503-W001.

Sulfate was detected at a concentration of 325 mg/L in wet-event surface water sample 01-505-W002.

6.1.3.2 Extent of Surface Water Contamination

Barium, chromium, and copper were found primarily at sampling station 01-501, located in a ponding area on the east side of the SWLF. Chromium was detected at a concentration of 0.022 mg/L and copper at 0.032 mg/L. Cadmium was detected at concentrations ranging from 0.005 to 0.066 mg/L.

6.1.4 Conclusions And Recommendations

Petroleum hydrocarbons and metals were detected in soil samples collected below a depth of 10 fbls. VOCs, petroleum hydrocarbons, and metals were detected in groundwater samples. Elevated

indicator parameters are also indicative that groundwater is contaminated by the wastes buried at the SWLF. Barium, cadmium, chromium, and copper were found in surface water collected from a ponding area located on the east side of the SWLF.

Data collected during the Phase II Stage 2 investigation did not adequately define groundwater flow direction to the west and northwest of the SWLF. Therefore, recommend that six piezometer wells, three shallow and three deep wells, be installed west and northwest of the SWLF to establish the groundwater gradient direction at the site.

6.2 NATURE AND EXTENT OF CONTAMINATED AT SITE NO. 2 (FTA-2)

Three soil borings (02-422, 02-423, 02-424) were drilled within the bermed burn pit to a depth of 30.0 fbls. During drilling, the soil core yielding the highest OVA reading in each of the three soil borings was collected from the 0-5 fbls interval. A petroleum odor was detected during drilling from soil boreholes 02-422 and 02-423. A foamy appearance was also noted on the surface of water present in these boreholes prior to grouting.

Three monitoring wells installed at FTA-2 during the previous Phase II Stage 1 investigation had been damaged or destroyed, and were replaced during the Phase II Stage 2 investigation with three new monitoring wells (02-164, 02-165, 02-166) which were installed around the perimeter of the pit outside the bermed area. No visible signs of contamination were observed during drilling of these monitoring wells, nor were any unusual odors noted.

Direction of groundwater flow is not consistent at the site. As of March 1988, groundwater flow was in a northerly direction (see Figure 4-36). As of August 1988, groundwater flow was in a southeast direction (see Figure 4-37). The basewide potentiometric map for shallow monitoring wells suggests that the FTA-2 area is located at a groundwater potentiometric low (see Figure 4-13). It appears that the groundwater at FTA-2 discharges to the stormwater system.

The 1 to 2-foot high berm constructed around the burn pit at FTA-2 is designed to contain waste fuel (JP-4) and firefighting water added to the site during fire training exercises. Some waste fuel and water was observed ponding in three small depressions in the wooded area northeast of the site. A dark staining of vegetation and the ground surface was also observed. Drainage of water and fuel mixtures to other areas outside the FTA-2 is possible.

Two surface water sampling stations, 02-508 and 02-509, were stormwater sewer locations, while surface water sampling stations 02-506 and 02-507 were located within depressions that collect water in the area surrounding the site.

6.2.1 Soil Contamination

No soil samples were collected at FTA-2 during the Phase II Stage 1 investigation.

One duplicate and nine investigative soil samples were collected from the three monitoring wells (02-164, 02-165, and 02-166) installed during the Phase II Stage 2 investigation. All samples were submitted for laboratory analysis of petroleum hydrocarbons, VOCs, soil moisture content, and metals screen including arsenic, mercury, and selenium.

6.2.1.1 Soil Quality

Table 6-4 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-4
Maximum Concentrations Detected in Soil at Site No. 2
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/kg)	Act 307 Type B Cleanup Criteria for Soil[a] and/or Estimated Background Levels[b] (mg/kg)
Methylene chloride	0.54	0.1[a]
Benzene	0.96	0.02[a]
Ethylbenzene	3.7	1.4[a]
Xylenes	15	6[a]
Petroleum hydrocarbons	3,800	ND
Arsenic	41.1	20[b]

ND = Not determined.
mg/kg = milligrams per kilogram.

Petroleum hydrocarbons were detected at concentrations ranging from 2,600 to 3,800 mg/kg in samples taken from the first 5 fbls in soil borings, at 150 mg/kg in samples taken from 5 to 10 fbls, and at less than 86 mg/kg below 10 fbls.

The VOCs methylene chloride, benzene, ethylbenzene, and xylenes were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels for soil. Methylene chloride was detected at concentrations of 0.44 mg/kg and 0.54 mg/kg in soil samples 02-422-B002 and 02-423-B001, respectively. Benzene was detected at a concentration of 0.96 mg/kg in the soil sample collected from soil boring 04-422 from a depth of 5.0 to 10.0 fbls. Ethylbenzene was detected in four of the nine soil samples in concentrations ranging from 1.6 to 3.7 mg/kg. Xylenes were detected at concentrations of 7.8, 12, and 15 mg/kg in soil samples 02-422-B001, 02-422-B002, and 02-424-B001, respectively.

Metals detected at FTA-2 all occurred in concentrations within the naturally occurring observed ranges for the eastern United States (see Table 4-19). However, arsenic was detected at concentrations exceeding the estimated background level for Selfridge ANGB (see Table 6-4) in soil samples 02-422-B002 (28.2 mg/kg), 02-423-B002 (22.6 mg/kg), and 02-424-B002 (41.1 mg/kg).

6.2.1.2 Extent of Soil Contamination

Petroleum hydrocarbons were detected in soil sampled at Site No. 2. Petroleum hydrocarbons were detected in all soil samples collected at Site No. 2, with the exception of the soil sample collected from soil boring 02-424 from a depth of 10.0 to 15.0 fbls. The most significant concentration occurs in the upper 5 feet of soil with concentrations of petroleum hydrocarbons ranging from 2,600 to 3,800 mg/kg. Petroleum hydrocarbon concentrations markedly decrease with depth. VOCs were detected in the first 10 feet of soil, but the highest concentrations were in the first 5 fbls.

Arsenic was detected in all soil borings from samples collected from a depth of 5.0 to 20.0 fbls. Arsenic concentrations ranged from 22.6 to 41.1 mg/kg. Results from these samples would indicate that they are in the leached or anaerobic zone and are fixed or immobilized.

6.2.2 Groundwater Contamination

During the Phase II Stage 2 investigation at Site No. 2, three monitoring wells were sampled. One duplicate and three groundwater samples were collected. All samples were submitted for laboratory analysis of petroleum hydrocarbons, purgeable halocarbons, purgeable aromatics, alkalinity, common anions, TDS, and metals screen including arsenic, lead, mercury, and selenium.

6.2.2.1 Groundwater Quality

Table 6-5 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-22), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-5
Maximum Concentrations Detected in Groundwater at Site No. 2
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/L)	Act 307 Type B Cleanup Criteria for Groundwater (mg/L)
Petroleum hydrocarbons	1	ND
Sulfate	292	250

ND = Not determined.
mg/L = milligrams per Liter.

Petroleum hydrocarbons were detected at 1 mg/L in groundwater samples collected from monitoring wells 02-164 and 02-165. Sulfate was detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels in groundwater samples collected from monitoring well 02-165.

6.2.2.2 Extent of Groundwater Contamination

Petroleum hydrocarbons were detected in groundwater samples collected from two of the three monitoring wells located at the site.

6.2.3 Surface Water Contamination

During the Phase II Stage 2 investigation at Site No. 2, four dry-event surface water samples and three wet-event surface water samples were collected. A wet-event surface water sample was not collected from sampling station 02-506 because of insufficient water. All samples were submitted for laboratory analysis of petroleum hydrocarbons, purgeable halocarbons, purgeable aromatics, alkalinity, common anions, TDS, and metals screen including arsenic, lead, mercury, and selenium.

6.2.3.1 Surface Water Quality

Table 6-6 summarizes the contaminants and maximum concentrations detected in surface water samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-23), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-6
Maximum Concentrations Detected in Surface Water at Site No. 2
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for GSI[a] and/or Estimated Background Levels[b]
Methylene chloride	390 ug/L	59 ug/L[a]
Petroleum hydrocarbons	2 mg/L	ND
Chromium	0.024 mg/L	0.0017 mg/L[a]
Copper	0.034 mg/L	0.018 mg/L[a]
Lead	0.17 mg/L	0.008 mg/L[a]
Alkalinity	2,500 mg/L	680 mg/L[b]

GSI = Groundwater/Surface Water Interface.
ND = Not determined.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter

The sample collected at surface water station 02-507 exhibited the greatest concentration of contamination. The VOC methylene chloride was detected in the dry-event surface water sample at a concentration exceeding Act 307 Type B Cleanup Criteria levels. Metals were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels (see Table 6-6). Chromium and lead were detected at concentrations of 0.024 mg/L and 0.17 mg/L, respectively, in the wet-event surface water samples. Copper and lead were detected at concentrations of 0.034 mg/L and 0.11 mg/L, respectively, in the dry-event surface water sample. Alkalinity was measured at a concentration of 2,500 mg/L in the wet-event sample, exceeding the background level for Selfridge ANGB (see Table 6-6).

Petroleum hydrocarbons were detected at a concentration of 2 mg/L in both surface water samples, 02-508-W001 and 02-509-W001, collected from the stormwater drainage system. These dry-event samples were collected from upgradient (02-508) and downgradient (02-509) catch basins along the 27-inch storm sewer line that lies 11 feet beneath FTA-2. Neither surface water sample collected at these two stations during the wet-event contained petroleum hydrocarbons.

Chromium was also detected at a concentration of 0.016 mg/L in dry-event surface water sample 02-506-W001.

6.2.3.2 <u>Extent of Surface Water Contamination</u>

Chromium, copper, and lead were found in surface water collected at sampling station 02-507, located within a shallow depression northeast of the fire training pit. Chromium was detected at a concentration of 0.024 mg/L and copper at a concentration of 0.034 mg/L. Lead was detected at concentrations ranging from 0.11 to 0.17 mg/L.

6.2.4 <u>Conclusions And Recommendations</u>

Petroleum hydrocarbons and VOCs were detected in the upper 10 feet of soil, but primarily in the first 5 fbls. Petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 1 mg/L. Chromium, copper, and lead were detected in surface water collected at sampling station 02-507, located within a shallow depression northeast of the site. Further investigation to characterize the site is not recommended.

6.3 <u>NATURE AND EXTENT OF CONTAMINATION AT SITE NO. 3 (FTA-1)</u>

Three soil borings (03-418, 03-419, 03-420) were drilled through the gravel-covered impoundment lot into the area believed to be within the old bermed fire training pit. Soil cores extracted from the soil borings at FTA-1 displayed consistently elevated OVA readings. The highest readings detected in soil samples were at boring 03-419 (10 to 100 units). The highest readings detected in vapors emanating from the soil borings were at borehole 03-418 (greater than 1,000 units). A petroleum odor was detected from near the bottom of the 0 to 5-foot soil core from soil boring 03-420. A black staining was observed on the fill material within the first 5 feet of the soil borings.

Three monitoring wells (03-116, 03-117, and 03-118) were installed during the IRP Phase II Stage 1 investigation around the perimeter of the fenced impoundment lot. Additional monitoring wells were not installed during the Phase II Stage 2 investigation. Direction of groundwater flow is not consistent at the site. As of March 1988, groundwater flow was to the northeast (see Figure 4-40). As of August 1988, groundwater flow was northerly (see Figure 4-41). Because of relatively flat gradients on the potentiometric surface for each measurement period, small changes in water levels will result in changes in groundwater flow direction.

There are no mechanisms for collecting and channeling surface water off the site. Surface water running off this site flows down the slopes and collects in the low-lying areas on the western, northern, and eastern sides. On the southern side, runoff would move directly onto Joy Road. The stormwater drainage system does not appear to receive any runoff from this site.

Access to the impound storage lot and former fire training pit area is controlled by a chain-link fence with a locked entry gate.

Minimization of direct contact is also achieved by the partial cap covering the site.

No surface water areas were present, and the stormwater drainage system does not directly drain the site; therefore, surface water samples were not collected at this site.

6.3.1 Soil Contamination

No soil samples were collected at FTA-1 during the Phase II Stage 1 investigation.

During the Phase II Stage 2 investigation at Site No. 3, two duplicate and nine investigative soil samples were collected from soil borings 03-418, 03-419, and 03-420. All samples were submitted for laboratory analysis of petroleum hydrocarbons, VOCs, SVOCs, soil moisture content, and metals screen including arsenic, mercury, and selenium.

6.3.1.1 Soil Quality

Table 6-7 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

The VOC vinyl chloride was detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels in both the soil sample (0.19 mg/kg) and duplicate soil sample (0.1 mg/kg) collected from a depth of 5.0 to 10.0 fbls from borehole 03-418.

Nine SVOCs were detected at concentrations shown in Table 6-7 in soil sample 03-420-B001, collected from a depth of 1.7 to 5.0 fbls.

Petroleum hydrocarbons were detected in both the soil sample (1,400 mg/kg) and duplicate soil sample (930 mg/kg) collected from a depth of 0 to 3.9 fbls from borehole 03-419. Petroleum hydrocarbons were detected from the soil samples collected at each sampling depth from borehole 03-420: 700 mg/kg from 1.7 to 5.0 fbls; 1,000 mg/kg from 5.0 to 9.5 fbls; and 230 mg/kg from 20.0 to 25.0 fbls.

The metals detected in the soil samples occurred in concentrations within the naturally occurring observed ranges for the eastern United States (see Table 4-19). However, three metals and arsenic were detected at concentrations exceeding background levels for Selfridge ANGB (see Table 6-7). Arsenic was detected at a concentration of 20.3 mg/kg in the duplicate soil sample collected from a depth of 5.0 to 10.0 fbls and at 24.4 mg/kg in the sample collected from a depth of 15.0 to 20.0 fbls from borehole 03-418. Cadmium was detected at a concentration of 32.5 mg/kg in the soil sample collected from a depth of 1.7 to 5.0 fbls, and nickel at 337 mg/kg in the sample collected from a depth of 20.0 to 25.0 fbls from borehole 03-420. Cobalt was detected at a concentration of

Table 6-7
Maximum Concentrations Detected in Soil at Site No. 3
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/kg)	Act 307 Type B Cleanup Criteria for Soil[a] and/or Estimated Background Levels[b] (mg/kg)
Vinyl chloride	0.19	0.0004[a]
Phenanthrene	1.2	ID
Benzo(a)anthracene	0.78	0.2[a]
Chrysene	0.76	0.2[a]
Bis(2-ethylhexyl)phthalate	0.65	0.04[a]
Benzo(b)fluoranthene	0.65	0.2[a]
Benzo(k)fluoranthene	0.37	0.2[a]
Benzo(a)pyrene	0.73	0.2[a]
Indeno(1,2,3-c,d)pyrene	0.7	0.2[a]
Benzo(g,h,i)perylene	0.68	ID
Petroleum hydrocarbons	1,400	ND
Arsenic	24.4	20.0[b]
Cadmium	32.5	2.0[b]
Cobalt	21.7	14.2[b]
Nickel	337	41.8[b]

ID = Insufficient data.
ND = Not determined.
mg/kg = milligrams per kilogram.

21.7 mg/kg in the soil sample collected from a depth of 5.0 to 9.2 fbls from borehole 03-419.

6.3.1.2 Extent of Soil Contamination

SVOCs detected in soil samples appear to be limited to soil boring 03-420, located within the old bermed fire training pit. The SVOCs detected are typical of coal tar or wood preservatives often used on railroad ties. Petroleum hydrocarbons were detected in soil samples collected to a depth of 25.0 fbls at concentrations ranging from 230 to 1,400 mg/kg.

Metals contamination does not occur in any significant or discernible pattern. Arsenic was detected in soil samples collected from borehole 03-418. Cadmium and nickel were detected at a concentration of 32.5 mg/kg and 337 mg/kg, respectively, in soil sampled from borehole 03-420.

6.3.2 Groundwater Contamination

During the Phase II Stage 2 investigation at Site No. 3, three monitoring wells were sampled. All samples were submitted for laboratory analysis of petroleum hydrocarbons, purgeable halocarbons, purgeable aromatics, alkalinity, common anions, TDS, and metals screen including arsenic, lead, mercury, and selenium.

6.3.2.1 Groundwater Quality

Table 6-8 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-22), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-8
Maximum Concentrations Detected in Groundwater at Site No. 3
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Groundwater
Petroleum hydrocarbons	1 mg/L	ND

ND = Not determined.
mg/L = milligrams per Liter.

Petroleum hydrocarbons were detected at a concentration of 1 mg/L in groundwater samples 03-116-M001 and 03-117-M001.

6.3.2.2 Extent of Groundwater Contamination

Petroleum hydrocarbons were detected in two of the three groundwater samples.

6.3.3 Surface Water Contamination

Surface water samples were not collected at this site.

6.3.4 Conclusions And Recommendations

Petroleum hydrocarbons and metals were detected in soil samples collected to a depth of 25.0 fbls. Petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 1 mg/L. Further investigation to characterize the site is not recommended.

6.4 NATURE AND EXTENT OF CONTAMINATION AT SITE NO. 4 (WRMP)

Ten soil borings (numbered 04-406 through 04-415) were drilled to a depth of 30 fbls. The borings are located around the perimeter of the WRMP adjacent to catch basins connected with the storm sewer drainage system. Visible evidence of potential subsurface contamination was limited to a brown, oil-like film observed on the continuous sampler after removal from borehole 04-412, and then again noted on the surface of water collected overnight in that borehole.

Five monitoring wells (04-111, 04-112, 04-113, 04-114, and 04-115) were installed at this site during the Phase II Stage I investigation. Monitoring well 04-114 was destroyed by base operations before the Phase II Stage 2 investigation commenced. During the Phase II Stage 2 investigation, eight additional monitoring wells were installed along the east and west sides of the WRMP: four shallow wells (04-148, 04-150, 04-152, and 04-154), and four deep wells (04-249, 04-251, 04-253, and 04-055). The shallow wells were drilled to depths ranging between 14.0 and 17.2 fbls. The deep wells were installed at depths ranging between 28.0 and 35.0 fbls. There was no visible evidence of potential subsurface contamination observed while drilling the monitoring well borings. Based upon the potentiometric surface maps, groundwater flow is generally toward the east.

Catch basins along the edge of the concrete surface serve as collection points for the majority of the stormwater runoff and connect to the stormwater drainage system. Four surface water sampling stations were located at critical junctions to monitor all surface water flow from the WRMP into the stormwater sewers.

There are no provisions to physically restrict access to the site or along its perimeter, but access to the flightline areas of the ramp itself is limited by procedure and policies.

6.4.1 Soil Contamination

During the Phase II Stage 1 investigation, fifteen soil samples were collected from monitoring well borings 04-111, 04-112, 04-113, 04-114, and 04-115. All samples were submitted for laboratory analysis of VOCs and oil and grease (O&G).

During the Phase II Stage 2 investigation at Site No. 4, three duplicate and thirty-one investigative soil samples were collected from ten soil borings. All samples were submitted for laboratory analysis of petroleum hydrocarbons, VOCs, and soil moisture content.

6.4.1.1 Soil Quality

Table 6-9 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 1 investigation, as reported in the Phase II Stage 2 investigation report, which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-9
Maximum Concentrations Detected in Soil at Site No. 4
Phase II Stage 1 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/kg)	Act 307 Type B Cleanup Criteria for Soil (mg/kg)
Benzene	24	0.020
Chloroethane	31	0.180
Chloroform	13	0.120
Ethylbenzene	5.2	1.4
Methylene chloride	98	0.1
Toluene	104,000	16
1,1,1-Trichloroethane	11	4
Trichloroethene	1,500	0.060
Trichlorofluoromethane	100	40
O&G	17,900	ND

ND = Not determined.
O&G = Oil and Grease.
mg/kg = milligrams per kilogram.

Oil and grease was detected at concentrations ranging from 65 to 17,900 mg/kg. Nine VOCs were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels (see Table 6-9). The analyses reportedly detected benzene at concentrations ranging from 4 to 24 mg/kg, chloroethane from 2 to 31 mg/kg, chloroform from 2 to 13 mg/kg, ethylbenzene from 2 to 5.2 mg/kg, methylene chloride from 3 to 98 mg/kg, toluene from 2 to 104,000 mg/kg, 1,1,1-trichloroethene from 2 to 11 mg/kg, trichloroethene from 60 to 1,500 mg/kg, and trichlorofluoromethane from 3 to 100 mg/kg.

Table 6-10 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-10
Maximum Concentrations Detected in Soil at Site No. 4
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Soil
Petroleum hydrocarbons	130 mg/kg	ND

ND = Not determined.
mg/kg = milligrams per kilogram.

Petroleum hydrocarbons were detected at concentrations ranging from 74 to 130 mg/kg in eight of the soil samples collected from soil borings installed at Site No. 4. All detected concentrations were below 100 mg/kg, with the exception of the sample collected from a depth of 5.0 to 10.0 fbls from soil boring 04-412, with a concentration of 130 mg/kg.

6.4.1.2 Extent of Soil Contamination

During the Phase II Stage 1 investigation, all soil samples collected from monitoring well borings 04-111, 04-112, 04-113, 04-114, and 04-115 reportedly contained trichloroethene, with one exception, and all samples contained one or two solvents. The only distinctive pattern of contamination readily observable was in samples collected from monitoring well boring 04-115, which was located adjacent to the source of the January 1984 spill. O&G was detected at a concentration of 17,900 mg/kg and toluene was detected at concentrations ranging from 25,000 to 104,000 mg/kg, as well as other solvents, in the samples collected from a depth of 2.5 to 7.5 fbls from monitoring well boring 04-115.

During the Phase II Stage 2 investigation, petroleum hydrocarbons were detected at a concentration of 90 mg/kg in soil sampled from soil boring 04-406, at 74 mg/kg from 04-407, at 80 mg/kg from 04-408, at 82 mg/kg from the duplicate soil sample collected from-04-410, at 89 mg/kg from 04-411, at 130 mg/kg from 04-412, at 82 mg/kg from 04-413, and at 80 mg/kg from soil collected from soil boring 04-414. Soil borings 04-112 and 04-414 are each located approximately 300 feet south and north, respectively, of monitoring well boring 04-115.

6.4.2 Groundwater Contamination

During the Phase II Stage 2 investigation at Site No. 4, twelve monitoring wells were sampled. One duplicate and twelve groundwater samples were collected. All samples were submitted for laboratory analysis of petroleum hydrocarbons, purgeable aromatics, alkalinity, common anions, and TDS.

6.4.2.1 Groundwater Quality

Table 6-11 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-22), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-11
Maximum Concentrations Detected in Groundwater at Site No. 4
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Groundwater
Benzene	2 ug/L	1 ug/L
Petroleum hydrocarbons	2 mg/L	ND
Chloride	415 mg/L	250 mg/L
Sulfate	962 mg/L	250 mg/L

ND = Not determined.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter.

The VOC benzene was detected at a concentration of 2 ug/L in groundwater sample 04-112-M001 which exceeds Act 307 Type B Cleanup Criteria levels for groundwater.

Petroleum hydrocarbons were detected at a concentration of 2 mg/L in both groundwater samples 04-112-M001 and 04-152-M001.

Both chloride and sulfate were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels. Chloride was detected at concentrations of 415 mg/L in groundwater sample 04-249-M001, 328 mg/L in sample 04-253-M001, and 385 mg/L in groundwater sample 04-255-M001. Sulfate was detected at concentrations of 298 mg/L in groundwater sample 04-112-M001 and 962 mg/L in sample 04-150-M001.

6.4.2.2 Extent of Groundwater Contamination

Benzene and petroleum hydrocarbons were detected in groundwater samples at maximum concentrations of 2 ug/L and 2 mg/L, respectively. Chloride and sulfate concentrations detected in

groundwater sampled from monitoring wells 04-249, 04-253, 04-255, 04-112, and 04-150 may be due to snow removal operations around the WRMP.

6.4.3 Surface Water Contamination

During the Phase II Stage 2 investigation at Site No. 4, one duplicate and four dry-event surface water samples, and one duplicate and four wet-event surface water samples were collected. All samples were submitted for laboratory analysis of petroleum hydrocarbons, purgeable aromatics, alkalinity, common anions, and TDS.

6.4.3.1 Surface Water Quality

Table 6-12 summarizes the contaminants and maximum concentrations detected in surface water samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-23), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-12
Maximum Concentrations Detected in Surface Water at Site No. 4
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for GSI
Petroleum hydrocarbons	2 mg/L	ND

GSI = Groundwater/Surface Water Interface.
ND = Not determined.
mg/L = milligrams per Liter.

Petroleum hydrocarbons were detected at concentrations ranging from 1.5 to 2 mg/L in all dry-event surface water samples.

6.4.3.2 Extent of Surface Water Contamination

Petroleum hydrocarbons were detected at a maximum concentration of 2 mg/L in dry-event surface water samples.

6.4.4 Conclusions And Recommendations

VOCs and petroleum hydrocarbons were detected in soil samples collected in the area adjacent to the source of the January 1984 spill. Benzene and petroleum hydrocarbons were detected in groundwater samples at maximum concentrations of 2 ug/L and 2 mg/L, respectively. Petroleum hydrocarbons were detected at a maximum

concentration of 2 mg/L in dry-event surface water samples. Further investigation to characterize the site is not recommended.

6.5 NATURE AND EXTENT OF CONTAMINATION AT SITE NO. 5 (TCLF)

A total of eight soil borings were drilled near stormwater catch basins around and within the TCLF area to determine if contaminants were migrating from the landfill area to these central drainage areas. Five soil borings (05-401, 05-402, 05-403, 05-404, and 05-405) were located adjacent to a gravel and cinder road along the northern and eastern perimeters of the TCLF. Three soil borings (05-416, 05-417, and 05-421) were located within the site boundary nearest the Selfridge ANGB school. No visible signs of subsurface contamination were observed nor any unusual odors noted during drilling of the soil borings.

Three shallow monitoring wells (05-105, 05-106, and 05-107) were installed and sampled during the Phase II Stage 1 investigation. During the Phase II Stage 2 investigation, seven additional monitoring wells were installed around and within the perimeter of the TCLF: four shallow wells (05-130, 05-132, 05-134, and 05-167), and three deep wells (05-231, 05-233, and 05-235). Monitoring well 05-167 was drilled as a replacement well for monitoring well 05-106. There was no visible evidence of potential subsurface contamination observed nor any unusual odors noted during drilling of the monitoring well borings.

Based upon the potentiometric surface maps, groundwater flow is generally toward the east across the site, but along the shoreline, flow is westward. The convergence of groundwater flow indicates that groundwater is being intercepted by the stormwater drainage network.

Surface water runoff from the TCLF is collected at stormwater catch basins located throughout the site and surrounding area. Five surface water sampling stations were established within the stormwater drainage system at TCLF. Station 05-518 was located at the lift station that pumps water into Lake St. Clair. The other four stations were located in stormwater sewer lines within TCLF.

Access to the TCLF site is unrestricted. The Selfridge ANGB school is located along the southern end of the TCLF site.

6.5.1 Soil Contamination

No soil samples were collected at the TCLF during the Phase II Stage 1 investigation.

During the Phase II Stage 2 investigation at Site No. 5, four duplicate and twenty-four investigative soil samples were collected. All samples were submitted for laboratory analysis of

petroleum hydrocarbons, VOCs, SVOCs, soil moisture content, and

metals screen including arsenic, mercury, and selenium.

6.5.1.1 Soil Quality

Table 6-13 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-13
Maximum Concentrations Detected in Soil at Site No. 5
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/kg)	Act 307 Type B Cleanup Criteria for Soil[a] and/or Estimated Background Levels[b] (mg/kg)
Bis(2-ethylhexyl)phthalate	0.4	0.04[a]
Benzo(g,h,i)perylene	0.1	ID
Phenanthrene	0.15	ID
Petroleum hydrocarbons	120	ND
Arsenic	43.2	20[b]
Copper	44.1	25[b]
Lead	82.2	--
Zinc	95.6	70[b]

ID = Insufficient data.
ND = Not determined.
mg/kg = milligrams per kilogram.

The SVOC bis(2-ethylhexyl)phthalate was detected at the concentration shown in Table 6-13 in the sample collected from a depth of 0 to 4.1 fbls from soil boring 05-421. Benzo(g,h,i)perylene was detected in both the soil sample (0.1 mg/kg) and duplicate sample (0.09 mg/kg) collected from a depth of 0 to 5.0 fbls from soil boring 05-403. Phenanthrene was also detected in both the soil sample (0.15 mg/kg) and duplicate sample (0.06 mg/kg) collected from a depth of 0 to 5.0 fbls from soil boring 05-403.

Petroleum hydrocarbons were detected at concentrations ranging from

75 to 120 mg/kg and occurred at all depths. Petroleum hydrocarbons were detected in soil borings 05-401 (95 to 99 mg/kg), 05-402 (100 mg/kg), 05-403 (83 to 98 mg/kg), 05-404 (110 mg/kg), 05-405 (120 mg/kg), and 05-417 (75 mg/kg).

All concentrations of metals were within the naturally occurring observed ranges for the eastern United States (see Table 4-19). Three metals and arsenic were detected at concentrations exceeding background levels for Selfridge ANGB (see Table 6-13). Arsenic was detected at a concentration of 43.2 mg/kg in the duplicate soil sample collected from a depth of 0 to 5.0 fbls from soil boring 05-403, and at 24 mg/kg in the duplicate soil sample collected from a depth of 15.0 to 20.0 fbls from soil boring 05-416. Copper was detected in soil samples collected from a depth of 0 to 5.0 fbls from soil borings 05-401 (44.1 mg/kg) and 5-402 (34.2 mg/kg). Lead was detected in both the soil sample (82.2 mg/kg) and duplicate sample (22.5 mg/kg) collected from a depth of 0 to 5.0 fbls from soil borings 05-403. Zinc was detected at concentrations of 95.6 mg/kg in soil sample 05-403-B001, 74.9 mg/kg in sample 05-416-B001, and 76.3 mg/kg in soil sample 05-417-B002.

6.5.1.2 Extent of Soil Contamination

The SVOCs benzo(g,h,i)perylene and phenanthrene were detected in concentrations of 0.06 to 0.15 mg/kg in the top five feet of soil collected from soil boring 05-403. A pile of old railroad ties located near the boring location may be the source of SVOC contamination.

Petroleum hydrocarbons were only detected in the soil borings located adjacent to the gravel and cinder road, with the exception of soil boring 05-417, located in the north portion of the site. Petroleum hydrocarbons were detected at concentrations ranging from 83 to 120 mg/kg in soil sampled from the five soil borings located adjacent to the gravel and cinder road. Petroleum hydrocarbons were detected at a concentration of 75 mg/kg in soil sampled from soil boring 05-417.

Metals were detected primarily in the top five feet of soil collected from soil borings 05-401, 05-402, and 05-403 located along the gravel and cinder road. Lead was detected in both the soil sample (82.2 mg/kg) and duplicate sample (22.5 mg/kg) collected from a depth of 0 to 5.0 fbls from soil boring 05-403. Arsenic and zinc were also detected at concentrations of 43.2 mg/kg and 95.6 mg/kg, respectively, in the soil samples collected from a depth of 0 to 5.0 fbls from soil boring 05-403. Copper was detected in soil samples collected from a depth of 0 to 5.0 fbls from soil borings 05-401 (44.1 mg/kg) and 5-402 (34.2 mg/kg).

6.5.2 Groundwater Contamination

During the Phase II Stage 2 investigation at Site No. 5, nine monitoring wells were sampled. One duplicate and nine groundwater samples were collected. All samples were submitted for laboratory analysis of purgeable aromatics, purgeable halocarbons, extractable

priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, COD, TOC, alkalinity, and TDS.

6.5.2.1 Groundwater Quality

Table 6-14 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-22), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-14
Maximum Concentrations Detected in Groundwater at Site No. 5
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Groundwater[a] and/or Estimated Background Levels[b]
Trichloroethene	4.1 ug/L	3 ug/L[a]
Benzene	2 ug/L	1 ug/L[a]
Bis(2-ethylhexyl)phthalate	4 ug/L	2 ug/L[a]
1,4-dichlorobenzene	2 ug/L	1 ug/L[a]
Petroleum hydrocarbons	4.1 mg/L	ND
Arsenic	0.007 mg/L	0.00002 mg/L[a]
Cadmium	0.008 mg/L	0.004 mg/L[a]
Lead	0.005 mg/L	I
Alkalinity	790 mg/L	670 mg/L[b]
TDS	4,500 mg/L	1,400 mg/L[b]
Chloride	2,360 mg/L	250 mg/L[a]
Sulfate	260 mg/L	250 mg/L[a]

I = Under review.
ND = Not determined.
TDS = Total Dissolved Solids.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter.

The VOCs trichloroethene and benzene were detected at concentrations shown in Table 6-14 in groundwater sample 05-107-M001.

The SVOC bis(2-ethylhexyl)phthalate was detected in eight of the nine groundwater samples and may be indicative of laboratory contamination. 1,4-dichlorobenzene was detected at the concentration shown in Table 6-14 in groundwater sample 05-167-M001.

Petroleum hydrocarbons were detected in six of the nine groundwater samples collected at concentrations ranging from 1 to 4.1 mg/L. The highest concentrations were detected in monitoring wells 05-132 and 05-235.

Arsenic and cadmium were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels. Arsenic was detected at a concentration of 0.007 mg/L in groundwater sample 05-235-M001. Cadmium was detected at concentrations of 0.006 mg/L in groundwater samples 05-107-M001 and 05-130-M101, and at 0.008 mg/L in groundwater samples 05-167-M001 and 05-233-M001. Lead was detected in groundwater sample 05-231-M001.

Alkalinity and TDS were measured at concentrations exceeding background levels for Selfridge ANGB (see Table 6-14). Alkalinity was measured at a concentration of 790 mg/L in groundwater sample 05-134-M001. TDS concentrations ranging from 1,700 to 4,500 mg/L were measured in seven of the nine groundwater samples analyzed.

Chloride and sulfate were detected in concentrations exceeding Act 307 Type B Cleanup Criteria levels (see Table 6-14). Chloride was detected at concentrations ranging from 450 to 2,360 mg/L in groundwater samples collected from all monitoring wells, with the exception of 05-130 and 05-134. Sulfate was detected at a concentration of 260 mg/L in groundwater sample 05-132-M001.

6.5.2.2 Extent of Groundwater Contamination

VOC contamination appears limited to groundwater sampled from monitoring well 05-107, located on the east end of the site. Trichloroethene and benzene were detected at concentrations of 4.1 ug/L and 2 ug/L, respectively.

Petroleum hydrocarbons were detected in groundwater samples collected from three shallow monitoring wells (05-105, 05-107, and 05-132) at concentrations ranging from 1 to 4.1 mg/L. The greatest concentration of petroleum hydrocarbons detected in the shallow aquifer is south and upgradient to the site (see Figure 6-1). Petroleum hydrocarbons were detected in groundwater samples collected from three deep monitoring wells (05-231, 05-233, and 05-235) at concentrations ranging from 1.2 to 4.1 mg/L. The greatest concentration of petroleum hydrocarbons detected in the deeper aquifer appears to the west of the site (see Figure 6-2).

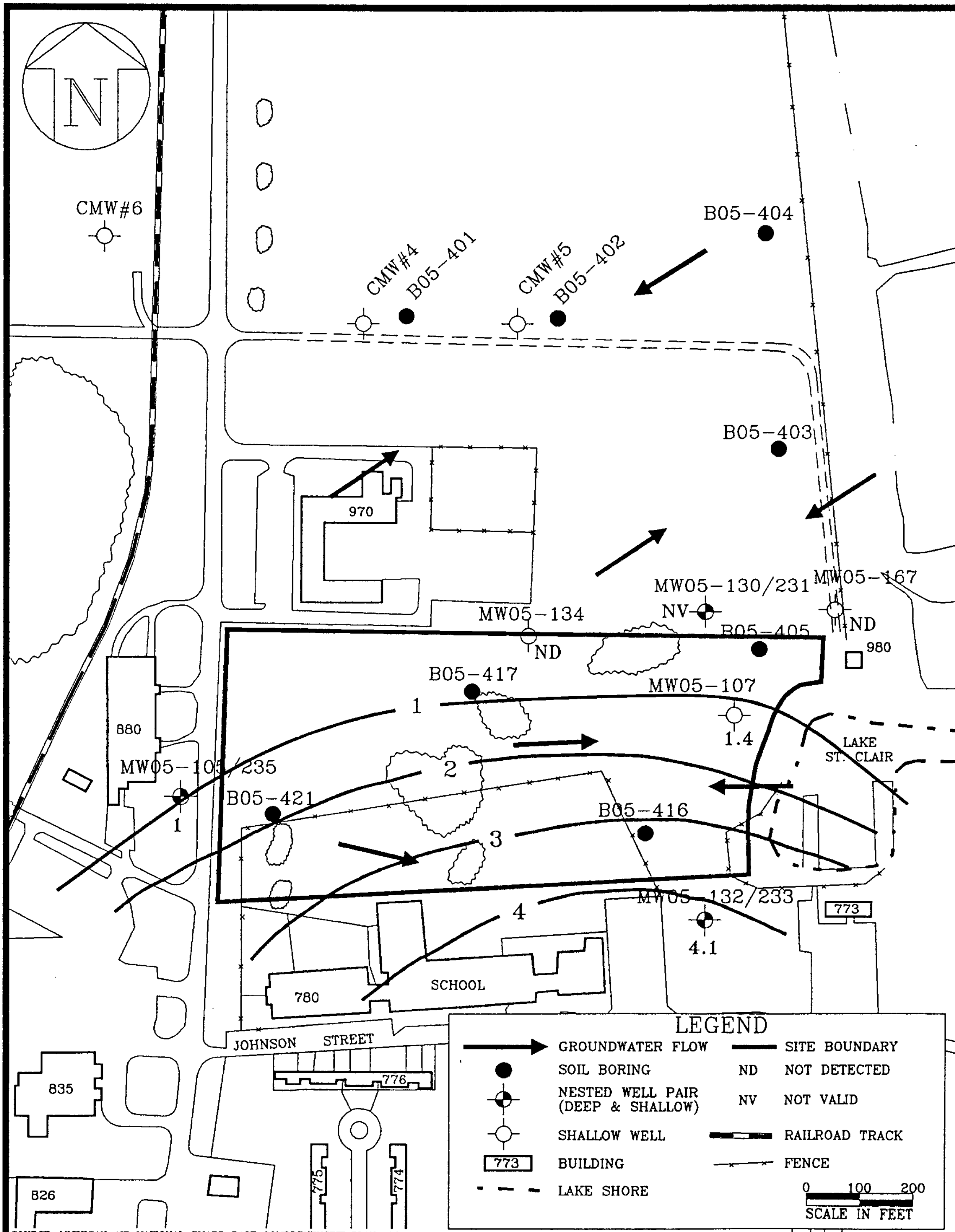

FIGURE 6.1

MIC6-1PE

PETROLEUM HYDROCARBONS CONCENTRATIONS IN THE SHALLOW AQUIFER AT SITE NO.5
Selfridge Air National Guard Base
Mt. Clemens, Michigan

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9 APR 1993

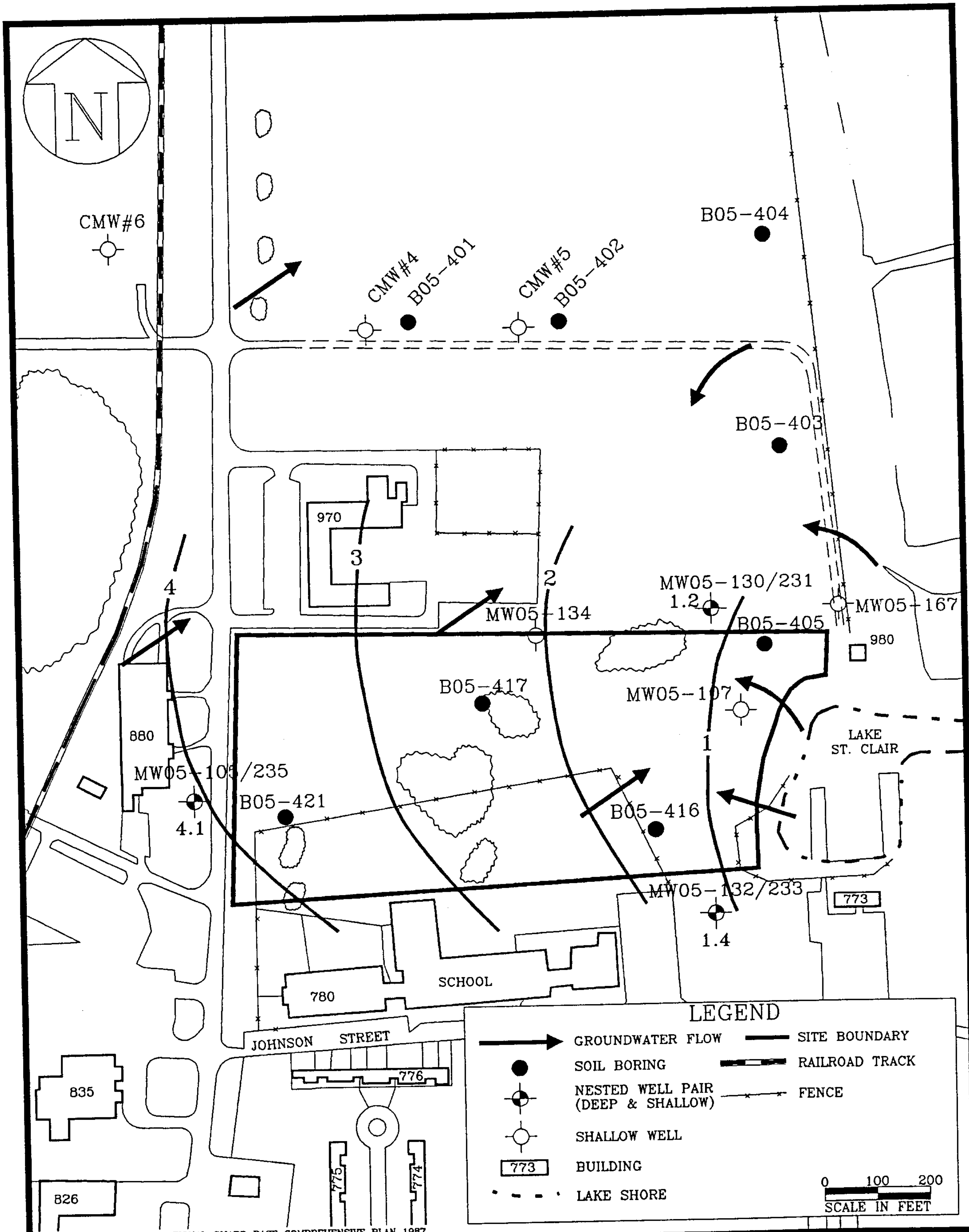

FIGURE 6.2

MIC6-2PE

PETROLEUM HYDROCARBONS CONCENTRATIONS IN THE DEEP AQUIFER AT SITE NO.5
Selfridge Air National Guard Base
Mt. Clemens, Michigan

OPTECH
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9 APR 1993

The elevated indicator parameters and metals concentrations are characteristic of landfill leachate. However, groundwater migration away from the TCLF is restricted by the stormwater network that truncates the water table, resulting in a potentiometric low in the eastern portion of the site. Groundwater flow is toward the center of the TCLF from the east and west, thereby restricting migration of contaminants away from the TCLF.

6.5.3 Surface Water Contamination

During the Phase II Stage 2 investigation at Site No. 5, five dry-event and five wet-event surface water samples were collected. All samples were submitted for laboratory analysis of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), alkalinity, common anions, ammonia, COD, TOC, and TDS.

6.5.3.1 Surface Water Quality

Table 6-15 summarizes the contaminants and maximum concentrations detected in surface water samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-23), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-15
Maximum Concentrations Detected in Surface Water at Site No. 5
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for GSI[a] and/or Estimated Background Levels[b] (mg/L)
Butyl benzyl phthalate	3 ug/L	N/A
Di-n-butyl phthalate	2 ug/L	N/A
Petroleum hydrocarbons	2.5 mg/L	ND
Cadmium	0.008 mg/L	0.0006[a]
Chromium	0.017 mg/L	0.0017[a]
Copper	0.035 mg/L	0.018[a]
Lead	0.033 mg/L	0.008[a]
Chloride (dry-event)	1,340 mg/L	186[b]
Chloride (wet-event)	1,280 mg/L	328[b]
TDS (dry-event)	2,500 mg/L	690[b]
TDS (wet-event)	2,000 mg/L	1,400[b]

GSI = Groundwater/Surface Water Interface. N/A = Not Available.
ND = Not determined.
ug/L = micrograms per Liter.
TDS = Total Dissolved Solids.
mg/L = milligrams per Liter.

The samples collected at surface water station 05-515 exhibited the highest concentration of contamination. The SVOC butyl benzyl phthalate was detected at a concentration of 3 ug/L in the dry-event surface water sample. Metals were detected in concentrations exceeding Act 307 Type B Cleanup Criteria levels. Cadmium, chromium, copper, and lead were detected at concentrations of 0.006, 0.017, 0.031, and 0.033 mg/L, respectively, in the wet-event surface water sample. Copper and lead were detected at concentrations of 0.029 mg/L and 0.019 mg/L, respectively, in the dry-event surface water sample.

The SVOC di-n-butyl phthalate was detected at a concentration of 2 ug/L and 1 ug/L in wet-event surface water samples 05-514-W002 and 05-516-W002, respectively.

Petroleum hydrocarbons were detected at concentrations ranging from 1.1 to 2.5 mg/L in all dry-event surface water samples. Petroleum hydrocarbons detections for wet-event samples were invalidated as petroleum hydrocarbons were detected in the associated equipment blanks.

In general, wet-event surface water samples contained more metals and at higher concentrations than dry-event samples. Cadmium was detected at a concentration of 0.008 mg/L in dry-event surface water sample 05-514-W001. Copper was detected at concentrations of 0.035 mg/L in dry-event surface water sample 05-516-W001, and at 0.025 mg/L in both wet-event surface water samples 05-517-W002 and 05-518-W002. Lead was detected at concentrations of 0.01 mg/L and 0.028 mg/L in wet-event surface water samples 05-516-W002 and 05-517-W002, respectively.

Chlorides and TDS concentrations were detected at levels exceeding background concentrations for Selfridge ANGB (see Table 6-15). Chlorides were detected in both the dry-event and wet-event surface water samples collected from stations 05-514 and 05-515. TDS was detected above background levels in both the dry-event and wet-event surface water samples collected from station 05-514.

6.5.3.2 Extent of Surface Water Contamination

Metals were detected primarily in surface water collected at sampling station 05-515, located in the stormwater sewer line in the southwest corner of the TCLF site and at sampling station 05-516, located in the stormwater sewer line in the east portion of the site. In the surface water collected at sampling station 05-515, cadmium and chromium were detected at concentrations of 0.006 mg/L and 0.017 mg/L, respectively. Copper and lead were detected at concentrations ranging from 0.029 to 0.031 mg/L and 0.019 to 0.033 mg/L, respectively. Surface water sampled at station 05-516 contained copper at a concentration of 0.035 mg/L and lead at 0.01 mg/L.

Elevated chloride and TDS concentrations in surface water sampled at stations 05-514 and 05-515, located near the roadways, may be a result of salt application during winter months.

6.5.4 Conclusions And Recommendations

Arsenic and zinc were detected at concentrations marginally greater than background levels in soil borings drilled within the defined boundary of the TCLF. Elevated indicator parameters and metals concentrations, characteristic of landfill leachate, were detected in groundwater. Petroleum hydrocarbons were detected in both the shallow and deeper aquifer underlying the TCLF; however, the TCLF does not appear to be the source of contamination. The greatest concentration of petroleum hydrocarbons detected in the shallow aquifer is south and upgradient to the site. The greatest concentration of petroleum hydrocarbons detected in the deeper aquifer appears to the west of the site. Cadmium, chromium, copper, and lead were detected in surface water collected from sampling station 05-515. Copper and lead were detected at sampling station 05-516 located in a stormwater sewer line downgradient to sampling station 05-515. No further investigation of the site is recommended.

6.6 NATURE AND EXTENT OF CONTAMINATION AT SITE NO. 6 (NWLF)

Soil borings were not installed during the Phase II Stage 2 investigation at this site. A total of two soil samples were collected from two monitoring well borings, 06-245 located in the northeastern corner and 06-247 located just to the west of the NWLF.

Four monitoring wells were installed during this investigation. Two shallow wells (06-144 and 06-146) were drilled to depths ranging between 16.0 and 17.5 fbls. Two deep wells (06-245 and 06-247) were installed at depths ranging between 28.0 and 35.0 fbls. Three shallow monitoring wells (06-108, 06-109, and 06-110) were previously installed during the Phase II Stage 1 investigation to depths ranging between 25.0 and 28.0 fbls. All wells are located around the perimeter of the NWLF. Visible evidence of soil contamination at the site was limited to a yellowish, oily-looking film present on the surface of the soil core collected from a depth of 15.0 to 20.0 fbls from monitoring well boring 06-247. No unusual odors were noted during drilling at NWLF. Based on the potentiometric surface maps, groundwater flow is generally toward the south and southwest in the shallow aquifer and toward the south and southeast in the deeper aquifer.

There are no engineering measures to prevent or control surface water runoff from the site. A portion of the stormwater drainage network is located along the southern edge of the NWLF site. Catch basins are located here, as well as to the southeast of the site. Surface water runoff from the southern portion of the NWLF is intercepted by these catch basins. There are two surface drainage ditches at the NWLF, one on the western border that drains runoff into the second ditch along the northern border of the NWLF. Two surface water sampling stations were established in the stormwater system at NWLF. Station 06-519 was located at a catch basin along

a sewer that drains an area to the southwest of the NWLF, and 06-520 was placed in a catch basin along a sewer line that drains the eastern portion of the NWLF.

Access to the NWLF is not restricted by any physical means.

6.6.1 Soil Contamination

No soil samples were collected at the NWLF during the Phase II Stage 1 investigation.

During the Phase II Stage 2 investigation at Site No. 6, two investigative soil samples were collected from monitoring well borings 06-245 and 06-247. All samples were submitted for laboratory analysis of petroleum hydrocarbons, VOCs, SVOCs, soil moisture content, and metals screen including arsenic, mercury, and selenium.

6.6.1.1 Soil Quality

Table 6-16 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-16
Maximum Concentrations Detected in Soil at Site No. 6
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/kg)	Act 307 Type B Cleanup Criteria for Soil[a] and/or Estimated Background Levels[b] (mg/kg)
Petroleum hydrocarbons	96	ND
Boron	52.9	36[b]

mg/kg = milligrams per kilogram.
ND = Not determined.

Petroleum hydrocarbons were detected at a concentration of 96 mg/kg in the soil sample collected from monitoring well boring 06-247 from a depth of 5.0 to 10.0 fbls. Boron was also detected in this same sample at a concentration of 52.9 mg/kg which exceeds the background level for Selfridge ANGB (see Table 6-16).

6.6.1.2 Extent of Soil Contamination

Petroleum hydrocarbons were detected at a concentration of 96 mg/kg in soil sampled from monitoring well boring 06-247, located to the west of the NWLF.

6.6.2 Groundwater Contamination

During the Phase II Stage 2 investigation at Site No. 6, seven monitoring wells were sampled. One duplicate and seven groundwater samples were collected. All samples were submitted for laboratory analysis of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), common anions, ammonia, COD, TOC, alkalinity, and TDS.

6.6.2.1 Groundwater Quality

Table 6-17 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-22), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-17
Maximum Concentrations Detected in Groundwater at Site No. 6
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Groundwater[a] and/or Estimated Background Levels[b]
Bis(2-ethylhexyl)phthalate	9 ug/L	2 ug/L[a]
Arsenic	0.01 mg/L	0.00002 mg/L[a]
Sulfate	432 mg/L	250 mg/L[a]
COD	540 mg/L	100 mg/L[b]

COD = Chemical Oxygen Demand.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter.

The SVOC bis(2-ethylhexyl)phthalate was detected at concentrations ranging from 3 to 9 ug/L in six of the seven groundwater samples and may be indicative of laboratory contamination.

Arsenic was detected at a concentration of 0.01 mg/L in groundwater samples collected from monitoring wells 06-144 and 06-247.

Sulfate was detected at a concentration exceeding Act 307 Type B Cleanup Criteria levels in groundwater sample 06-108-M001. COD was measured above background levels for Selfridge ANGB (see Table 6-17). COD was measured at concentrations ranging from 250 to 540 mg/L in three of the seven groundwater samples analyzed and in the duplicate sample collected from monitoring well 06-144.

6.6.2.2 Extent of Groundwater Contamination

Arsenic was detected in groundwater samples at a maximum concentration of 0.01 mg/L.

6.6.3 Surface Water Contamination

During the Phase II Stage 2 investigation at Site No. 6, two dry-event and two wet-event surface water samples were collected. All samples were submitted for laboratory analysis of purgeable aromatics, purgeable halocarbons, extractable priority pollutants, petroleum hydrocarbons, metals screen (including arsenic, lead, mercury, and selenium), alkalinity, common anions, ammonia, COD, TOC, and TDS.

6.6.3.1 Surface Water Quality

Table 6-18 summarizes the contaminants and maximum concentrations detected in surface water samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-23), and/or Act 307 Type B Cleanup Criteria levels.

The samples collected at surface water station 06-520 exhibited the greatest concentration of contamination. Metals were detected at concentrations exceeding either Act 307 Type B Cleanup Criteria levels or background concentrations in both the dry-event and wet-event surface water samples collected at station 06-520. Arsenic was detected at a concentration of 0.242 mg/L, barium at 1.31 mg/L, cadmium at 0.02 mg/L, and nickel at 0.269 mg/L in the wet-event surface water sample. Chromium was detected at a concentration of 0.029 mg/L and 0.188 mg/L in the dry-event and wet-event surface water sample, respectively. Copper was detected at a concentration of 0.054 mg/L and 0.238 mg/L in the dry-event and wet-event surface water sample, respectively. Lead was detected at a concentration of 0.056 mg/L and 0.592 mg/L in the dry-event and wet-event surface water sample, respectively.

The SVOCs butyl benzyl phthalate was detected at a concentration of 4 ug/L in the dry-event surface water sample and di-n-butyl phthalate at a concentration of 1 ug/L in the wet-event surface water sample collected from station 06-519.

Petroleum hydrocarbons were detected at a concentration of 1.7 mg/L in dry-event surface water sample 06-519-W001.

COD concentrations exceeded the background level for Selfridge ANGB (see Table 6-18), only in the two dry-event surface water samples collected.

Table 6-18
Maximum Concentrations Detected in Surface Water at Site No. 6
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for GSI[a] and/or Estimated Background Levels[b] (mg/L)
Butyl benzyl phthalate	4 ug/L	N/A
Di-n-butyl phthalate	1 ug/L	N/A
Petroleum hydrocarbons	1.7 mg/L	ND
Arsenic	0.242 mg/L	0.180[a]
Barium (wet-event)	1.31 mg/L	0.385[b]
Cadmium	0.02 mg/L	0.0006[a]
Chromium	0.188 mg/L	0.0017[a]
Copper	0.238 mg/L	0.018[a]
Nickel	0.269 mg/L	0.057[a]
Lead	0.592 mg/L	0.008[a]
COD (dry-event)	160 mg/L	57[b]

GSI = Groundwater/Surface Water Interface.
N/A = Not Available.
ND = Not determined.
COD = Chemical Oxygen Demand.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter.

6.6.3.2 Extent of Surface Water Contamination

Metals were detected in surface water sampled from sampling station 06-520, located in a catch basin along a sewer line that drains the eastern portion of the NWLF. Arsenic was detected at a concentration of 0.242 mg/L, cadmium at 0.02 mg/L, and nickel at 0.269 mg/L. Chromium was detected at concentrations ranging from 0.029 to 0.188 mg/L, copper from 0.054 to 0.238 mg/L, and lead from 0.056 to 0.592 mg/L.

6.6.4 Conclusions And Recommendations

Arsenic was detected in groundwater samples at a maximum concentration of 0.01 mg/L. Arsenic, cadmium, chromium, copper, lead, and nickel were detected in surface water collected from a catch basin located along a sewer line that drains the eastern portion of the NWLF. Further investigation to characterize the site is not recommended.

6.7 NATURE AND EXTENT OF CONTAMINATION AT SITE NO. 7 (ERMP)

Two soil borings (07-428 and 07-429) were drilled to a depth of 30 fbls at this site. The borings were located to the northeast and southwest of the ERMP, near catch basins leading to major junctions of the stormwater drainage system. There were no visible signs of soil contamination observed nor any unusual odors noted during drilling of the soil borings.

Four monitoring wells (07-101, 07-102, 07-103, and 07-104) were installed around the perimeter of the ERMP during the Phase II Stage 1 investigation. Monitoring well 07-101 was destroyed before the Phase II Stage 2 investigation commenced. During the Phase II Stage 2 investigation, eight additional monitoring wells were installed around the perimeter of ERMP: four shallow wells (07-136, 07-138, 07-140, and 07-142), and four deep wells (07-237, 07-239, 07-241, and 07-243). There were no visible signs of contamination observed nor any unusual odors noted during drilling of the Phase II Stage 2 monitoring well borings. The potentiometric surface maps show groundwater flow in the shallow aquifer along the southern portion of the site to be toward the northeast, while near Lake St. Clair, groundwater flow reverses to the southwest toward the site. Groundwater flow in the deeper aquifer is generally from the north and south toward a trough in the potentiometric surface underlying the ERMP.

Four surface water sampling stations were established in the stormwater drainage system at the ERMP. They were placed at primary sewer pipe junctions to monitor all surface water flowing from ERMP into the stormwater drainage system.

There are no provisions to physically restrict access to the site. The ERMP is patrolled to prevent unauthorized access to the area.

6.7.1 Soil Contamination

During the Phase II Stage 1 investigation, twelve soil samples were collected from monitoring well borings 07-101, 07-102, 07-103, and 07-104. All samples were submitted for laboratory analysis of VOCs and O&G.

During the Phase II Stage 2 investigation at Site No. 7, one duplicate and seven investigative soil samples were collected from two soil borings. All samples were submitted for laboratory analysis of petroleum hydrocarbons, VOCs, and soil moisture content.

6.7.1.1 Soil Quality

Table 6-19 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 1 investigation, as reported in the Phase II Stage 2 investigation report, which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-19
Maximum Concentrations Detected in Soil at Site No. 7
Phase II Stage 1 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/kg)	Act 307 Type B Cleanup Criteria for Soil (mg/kg)
Chloroform	490	0.12
Methylene chloride	1,800	0.1
Toluene	60	16
1,1,1-Trichloroethane	2,100	4
1,1,2-Trichloroethane	1,000	0.012
Trichloroethene	6,800	0.06
O&G	229	ND

ND = Not determined.
O&G = Oil and Grease.
mg/kg = milligrams per kilogram.

O&G were detected at concentrations ranging from 69 to 229 mg/kg. Six VOCs were detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels (see Table 6-19). The analyses reportedly detected chloroform at concentrations ranging from 2 to 490 mg/kg, methylene chloride from 3 to 1,800 mg/kg, toluene from 2 to 60 mg/kg, 1,1,1-trichloroethane from 2 to 2,100 mg/kg, 1,1,2-trichloroethane from 2 to 1,000 mg/kg, and trichloroethene from 107 to 6,800 mg/kg. Every soil sample reportedly contained trichloroethene, with the highest concentrations detected predominantly in the 15.5 and 25 foot levels.

Table 6-20 summarizes the contaminants and maximum concentrations detected in soil samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-20), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-20
Maximum Concentrations Detected in Soil at Site No. 7
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Soil
Petroleum hydrocarbons	99 mg/kg	ND

ND = Not determined.
mg/kg = milligrams per kilogram.

Petroleum hydrocarbons were detected at a concentration of 99 mg/kg in soil sample 07-428-B003 collected from a depth of 20.0 to 24.8 fbls. Petroleum hydrocarbons were also detected at a concentration of 79 mg/kg in the spike duplicate sample 07-429-B003 collected from a depth of 25.0 to 30.0 fbls.

6.7.1.2 Extent of Soil Contamination

Petroleum hydrocarbons were detected in soil samples collected below a depth of 20 fbls. Petroleum hydrocarbons were detected at a concentration of 99 mg/kg in soil sample 07-428-B003 collected from a depth of 20.0 to 24.8 fbls. Petroleum hydrocarbons were also detected at a concentration of 79 mg/kg in the spike duplicate sample 07-429-B003 collected from a depth of 25.0 to 30.0 fbls.

Soil samples collected during the Phase II Stage 2 investigation did not confirm the VOC contamination detected in soil during the previous Phase II Stage 1 investigation.

6.7.2 Groundwater Contamination

During the Phase II Stage 2 investigation at Site No. 7, all eleven monitoring wells were sampled. One duplicate and eleven investigative groundwater samples were collected. All samples were submitted for laboratory analysis of purgeable aromatics, petroleum hydrocarbons, common anions, alkalinity, and TDS.

6.7.2.1 Groundwater Quality

Table 6-21 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-22), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-21
Maximum Concentrations Detected in Groundwater at Site No. 7
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected (mg/L)	Act 307 Type B Cleanup Criteria for Groundwater[a] and/or Estimated Background Levels[b] (mg/L)
Petroleum hydrocarbons	2.1	ND
Alkalinity	5,700	670[b]
TDS	13,000	1,400[b]
Chloride	553	250[a]

ND = Not determined.
TDS = Total Dissolved Solids.
mg/L = milligrams per Liter.

Petroleum hydrocarbons were detected in concentrations ranging from 1.1 to 2.1 mg/L in six of the eleven groundwater samples and in the one duplicate sample.

Alkalinity and TDS concentrations exceeded background levels for Selfridge ANGB (see Table 6-21), in groundwater sample 07-237-M001. Chloride was detected at concentrations exceeding Act 307 Type B Cleanup Criteria levels in groundwater samples 07-102-M001 (553 mg/L) and 07-241-M001 (500 mg/L).

6.7.2.2 <u>Extent of Groundwater Contamination</u>

Petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 2.1 mg/L. The high indicator parameter values measured may be possibly unrelated to petroleum spills. The high alkalinity and TDS concentrations measured at 5,700 mg/L and 13,000 mg/L, respectively, in groundwater sampled from monitoring well 07-237 may be due to a steam leak. The elevated chloride concentrations detected in groundwater sampled from monitoring wells 07-102 and 07-241 may be due to vehicular traffic tracking salt from de-wintering operations.

6.7.3 <u>Surface Water Contamination</u>

During the Phase II Stage 2 investigation at Site No. 7, four dry-event and four wet-event surface water samples were collected. All samples were submitted for laboratory analysis of purgeable aromatics, petroleum hydrocarbons, alkalinity, common anions, and TDS.

6.7.3.1 Surface Water Quality

Table 6-22 summarizes the contaminants and maximum concentrations detected in surface water samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-23), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-22
Maximum Concentrations Detected in Surface Water at Site No. 7
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for GSI
Toluene	178 ug/L	111 ug/L
Petroleum hydrocarbons	4.6 mg/L	ND

GSI = Groundwater/Surface Water Interface.
ND = Not determined.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter.

The VOC toluene was detected at a concentration exceeding Act 307 Type B Cleanup Criteria levels in wet-event surface water sample 07-521-W002.

Petroleum hydrocarbons were detected at concentrations of 4.6 and 1.6 mg/L in the dry-event and wet-event surface water sample collected from station 07-521, respectively. Petroleum hydrocarbons were also detected at a concentration of 1.7 mg/L in the wet-event surface water sample collected from station 07-522.

6.7.3.2 Extent of Surface Water Contamination

Toluene was detected in the wet-event surface water sample collected from sampling station 07-521.

6.7.4 Conclusions And Recommendations

Soil samples collected during the Phase II Stage 2 investigation did not confirm the VOC contamination detected in soil during the previous Phase II Stage 1 investigation. Petroleum hydrocarbons were detected in soil samples collected below a depth of 20 fbls. Petroleum hydrocarbons were detected in groundwater samples at a maximum concentration of 2.1 mg/L. Toluene was detected in one surface water sample. Further investigation to characterize the site is not recommended.

6.8 NATURE AND EXTENT OF CONTAMINATION AT SITE NO. 8 (BCSP)

Three soil borings (08-425, 08-426, and 08-427) were drilled to a depth of 30 fbls at this site. There were no visible signs of soil contamination observed nor any unusual odors noted during drilling of the soil borings.

During the Phase II Stage 2 investigation, four shallow monitoring wells (08-126, 08-127, 08-128, and 08-129) were installed at this site. Based upon the potentiometric surface maps, groundwater flow from the BCSP is generally toward the northeast and south.

This site lacks features to control or contain surface water runoff. Surface water either ponds on the site or accumulates in low-lying areas along the sides of the site. No surface water sampling stations were established at the BCSP. There are no physical means of restricting access to this site.

6.8.1 Soil Contamination

No soil samples were collected at the BCSP during the previous Phase II Stage 1 investigation.

During the Phase II Stage 2 investigation conducted at Site No. 8, nine investigative soil samples were collected. All samples were submitted for laboratory analysis of SVOCs, soil moisture content, and metals screen including arsenic, mercury, and selenium.

6.8.1.1 Soil Quality

No SVOCs or metals were detected at concentrations exceeding either Act 307 Type B Cleanup Criteria levels for soil or estimated background concentrations for Selfridge ANGB, as determined by statistical study (see Table 4-20).

6.8.1.2 Extent of Soil Contamination

No soil contamination was detected at this site.

6.8.2 Groundwater Contamination

During the Phase II Stage 2 investigation, four monitoring wells were sampled. One duplicate and four groundwater samples were collected. All samples were submitted for laboratory analysis of extractable priority pollutants, metals screen (including arsenic, lead, mercury, and selenium), acidity, common anions, alkalinity, and TDS.

6.8.2.1 Groundwater Quality

Table 6-23 summarizes the contaminants and maximum concentrations detected in groundwater samples collected during the Phase II Stage 2 investigation which exceed background levels, as determined by statistical analysis (see Table 4-22), and/or Act 307 Type B Cleanup Criteria levels.

Table 6-23
Maximum Concentrations Detected in Groundwater at Site No.8
Phase II Stage 2 Investigation
Selfridge Air National Guard Base, Mt. Clemens, Michigan

Contaminant	Maximum Concentration Detected	Act 307 Type B Cleanup Criteria for Groundwater[a] and/or Estimated Background Levels[b]
Bis(2-ethylhexyl)phthalate	15 ug/L	2 ug/L[a]
Phenanthrene	3 ug/L	ID
Cadmium	0.013 mg/L	0.004 mg/L[a]
Chloride	6,800 mg/L	250 mg/L[a]
TDS	12,000 mg/L	1,400 mg/L[b]

ID = Insufficient data.
TDS = Total Dissolved Solids.
ug/L = micrograms per Liter.
mg/L = milligrams per Liter

The SVOC bis(2-ethylhexyl)phthalate was detected in all groundwater samples, including the duplicate sample, and may be indicative of laboratory contamination. Phenanthrene was detected in the groundwater sample collected from monitoring well 08-128.

Cadmium was detected at a concentration exceeding Act 307 Type B Cleanup Criteria levels in groundwater sample 08-129-M001.

Chloride concentrations exceeded Act 307 Type B Cleanup Criteria levels in groundwater samples 08-126-M001 (2,090 mg/L), 08-128-M001 (1,170 mg/L), and 08-129-M001 (6,800 mg/L). TDS exceeded background levels for Selfridge ANGB (see Table 6-23).

6.8.2.2 Extent of Groundwater Contamination

Elevated chloride and TDS concentrations may be a result of contamination from an area adjacent to the BCSP. Chloride was measured at concentrations ranging from 1,170 to 6,800 mg/L. TDS was measured at concentrations ranging from 1,700 to 12,000 mg/L.

Located next to the BCSP within the Roads and Grounds Maintenance Yard is Building 827, a storage area for road salt. Chloride and TDS concentrations decrease in the monitoring wells in the direction of groundwater flow away from the area of salt storage, with the exception of monitoring well 08-128. Concentrations in this well may be related to the use of road salt on the paved road located to the west of BCSP.

6.8.3 Surface Water Contamination

Surface water samples were not collected at this site.

6.8.4 Conclusions And Recommendations

Elevated chloride and TDS concentrations detected in groundwater samples appear to be related to the road-salt pile located adjacent to the BCSP. No further investigation of the site is recommended.

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